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INTRODUCING THE CONTRIBUTORS

C. C. FURNAS ("Energy—Come and Get It") was for somewhat more than a decade a professor of Chemical Engineering at Yale University, and now is Director of Research, Airplane Division, Curtiss-Wright Corporation. Dr. Furnas' technical reports have been concerned with the reduction of iron oxides, heat transfer, chemical and physical reactions in gas furnaces, and the combustion of carbon. His more general publications have included *The Next Hundred Years* and *The Storehouse of Civilization.*

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FLORENCE G. BILLIG ("Science in the Elementary School and the Air Age") delivered the paper, which *Science Education* publishes in this number, at regional meetings of the National Association for Research in Science Teaching. Dr. Billig, who is just completing a term as president of N.A.R.S.T., teaches science education at Wayne University and supervises science in the elementary schools of Detroit.

LOUISE STOLLBERG ("Still a Teacher of Science") went from Edgewood Park Junior College, where she was teaching biology, to her present position as State Nutritionist in the Vermont Extension Service. She soon found that she was still engaged in science education, although her students' needs and interests and her own teaching problems were very different than they had ever been before.

ANNA R. BURGESS and NATHAN A. NEAL ("Using Radio as a Tool in Science Instruction during the War Period") prepared their present article for the Cleveland meeting of N.A.R.S.T. The authors represent respectively the fields of elementary and secondary school science instruction. Miss Burgess has been principal of the Elementary Science Curriculum Center of the Cleveland Public Schools since 1932. Mr. Neal was a science teacher, head of a high school science department, and a curriculum construction worker in Cleveland until, in 1942, he was placed in charge of engineering and technical operation of radio station WBOE.

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ELLIS C. PERSING ("Bringing Science Teaching Up to Date") teaches in the West Technical High School, Cleveland, Ohio, and in the School of Education of Western Reserve University. In addition, he is editor of a volume in the *Book of Knowledge,* author of articles in a variety of publications, and co-author of *Elementary Science by Grades,* a series of six textbooks. He is interested in field work, having conducted university field trips in southern Utah, the Pacific Northwest, and

Alaska; and in visual education, especially in the production of natural color pictures.

HAROLD H. PUNKE ("Self and Science") is on leave from the Georgia State Woman's College at Valdosta for the duration of the war. For the past ten years he has been in charge of the Department of Education and Psychology at that institution. Dr. Punke has directed much of his attention to administration.

The section entitled "Teaching Suggestions and Reports" contains, first, directions for assembling a magnetizer, contributed by RAYMOND AGREN, a science teacher at Detroit's Southfield Vocational High School and a special instructor in physics at Wayne University. A device for having fun with static electricity is described by W. G. WHITMAN, chairman of the Committee on Publication of *Science Education*. PAUL F. BRANDWEIN, who describes a useful modification of the test tube, is chairman of the biology department of the Forest Hills High School, New York. HUBERT M. EVANS and HAROLD TANNENBAUM report an activity recently carried out in their biology classes.

Under the general heading, "Meetings of Significance," R. WILL BURNETT, who is interested in the effects of policy-making educational associations on the work of science teachers, comments on the work of the International Education Assembly as stated in its report of the Harpers Ferry Meeting. H. B. CROUCH, head of the Department of Biology at Kentucky State College, reports the planning conference of science teachers in Negro colleges. Dr. Crouch is executive secretary-treasurer of the organization whose formation he reports. GERALD S. CRAIG reports the joint regional meeting of the National Association for Research in Science Teaching and the National Council on Elementary Science. The meeting was held at Teachers College, Columbia University, where Dr. Craig is professor of Natural Sciences.

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ENERGY—COME AND GET IT

C. C. Furnas

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HUMAN beings will expend almost any effort to get some one or some thing to do their work for them. Until James Watt opened a new era, reliance was placed on beasts of burden and human slaves—plus rather indifferent, occasional harnessing of wind and falling water. Now almost every child of the western world grows up completely surrounded by kilowatts. We have become the most horse-powered people on earth, and we have just started. More than that, most of the people of the world are not moderns according to our industrial standards. When the people of the whole world become industrialized and travel-minded to the extent of us Americans, there will certainly be at least a ten-fold increase in the demands for inanimate energy, and the whole level of energy demand will probably continue to rise—even after every Chinese family has its automobile—for the potential demand for the utilization of inanimate slaves has no visible limit.

It is a fine trend. Being inherently as lazy as the next one, I am all for it and, besides, I think it will eventually lead us to a higher level of civilization where the good life can approach a mass reality. But there is potential trouble brewing here. When a nation runs short of food, revolution is on its way. If an industrial world should face an energy famine, what would the reaction be? It could sink into a new Dark Age, or it could try to do something about the problem. It is by no means too early to start doing something about it now. The race is already on for control of the power sources of the world. There may not be enough to go around for long, and unless some redistribution is accomplished there are going to be some spots of shortage distressingly soon. Americans do not look with any great favor on redistribution of the world's wealth; they would lose too much by a reshuffle. They would rather have their scientists and technologists solve the problems. That is probably the sounder approach: it involves less international politics.

In order to evaluate the problem which lies before us we must first take inventory of that which is on the shelves.

THE ORIGINAL SOURCE OF OUR ENERGY

Our principal sources of energy, in terms of quantity produced, are coal and petroleum (including gas), with water power bringing up the rear. Wood, at one time an important item in the American fuel economy, is now of minor importance. In the last analysis these fuels are all modified forms of solar energy. Coal and petroleum are solidified sunshine (in the form of the chemical products of photosynthesis) of a few hundred million years ago. Water

power comes from the water evaporated last week or last year. Wood represents the energy of leaf-captured sunshine of a few years' standing.

Coal and petroleum, on which we now put our principal reliance, are irrevocably expendable items. When they are gone, "that's all there is; there isn't any more." If new deposits are being formed anywhere on the earth's crust at present, it is only at a relatively infinitesimal rate; certainly not rapidly enough to catch up with the fast-moving human race. For the bulk of our power we are simply digging into a fossil storehouse graciously handed to us by chance. Thus far we have made essentially no progress toward replenishing it. Our civilization exists by the process of sponging on the past ages, and our prodigality cannot go on forever.

We can ignore the future and assume that there will be plenty for ourselves and our children, and perhaps for our grandchildren, and let posterity work out the answers when its turn comes to face the technical problems. But that, at its best, is certainly an unsportsmanlike policy, and at its worst, probably a foolish one.

HOW LONG WILL THEY LAST?

Petroleum is the most critical fuel material in America. In 1941 domestic consumption was about 1,400 million barrels. The petroleum reserve in the country is about 20 billion barrels, depending somewhat on who does the estimating. Thus the petroleum actually in sight is only about a fourteen-year supply. As new discoveries and improved prospecting techniques are coming forth constantly, many people in the petroleum industry say they are not worried about the supply, at least for the present generation. It is a little discouraging to note, however, that new discoveries are not quite keeping pace with use; the pinch of partial depletion may come sooner than the optimists anticipate. International jockeying for distribution of control of the petroleum resources of the Near East is already reported in the daily press.

Possibly extensive fields lie under the ocean next to coastal plains, as along the Gulf of Mexico. Large amounts of petroleum may be hidden at far greater depths than are yet explored. We hope so, but it should be remembered that if recovery is made from the more difficult places, the cost of production is certain to rise and the customer must pay it. It does not take a professional pessimist to visualize that the first half of the twentieth century will soon be looked back upon as the period of the last bonanza of mineral wealth—when oil flowed like water and could be had for the finding and taking.

Natural Gas

Natural gas is, and will continue to be for several years, a major energy source. United States government estimates in 1939 indicate a reserve of 66 trillion cubic feet, which at the 1939 rate of consumption of 2,500 billion cubic feet will last about twenty-five years. It is possible that new reserves will be located and methods of greater recovery developed, but in general gas suffers the same handicaps as its liquid cousin, petroleum. The least costly, most accessible supplies are tapped first, and even with great luck in new discoveries the age of United States gas reserves does not extend much beyond a generation.

Coal, Backbone of Our Energy Supply

In the coal business, the United States appears to be the most happily situated country in the world. We have 42 per cent of the estimated coal reserve of the world, but only 6 per cent of the world's population. This may seem hoggish, but it was chance that did it. Viewing the North American continent as a whole, the picture is even more one-sided, for within the continental boundaries is 69 per cent of the estimated world reserve and only 8 per cent of the population.

Since some American first threw a black diamond on a fire down to the present we

have consumed only about 0.7 per cent of our estimated reserve in this country. At the present rate of coal consumption, roughly 500 million tons per year, the United States has enough bituminous coal alone in sight within the continental boundaries to last three thousand years.

This array of data can easily have an enervating influence and lead one to believe that there is nothing to worry about. Who cares what happens three thousand years from now anyway! There are a few facts, however, that should be scrutinized before lapsing into placidity.

1. The better coal deposits, like the better apples on a tree, are few. As we pick the best (we are already past that point in the anthracite fields) the remaining deposits become more and more difficult to work. It will probably never be possible to get all the coal out of the ground; perhaps only a small fraction of it can be mined.

2. Coal deposits are localized. Great areas of our country and the rest of the world can be better and more economically served with some energy source other than coal.

3. If the remaining 94 per cent of the people of the world decide that the 6 per cent block—which is the United States—should give up a substantial portion of the 42 per cent of the coal reserve, there probably is not much to be done about it.

These facts indicate that an adequate coal supply may be ours for a much shorter period than a column of figures might indicate. We have to consider the world power picture in terms of our own resources.

ESTIMATED ORIGINAL COAL RESERVES IN THE UNITED STATES

Type of Coal	*Reserve Short Tons*
Lignite	939,584,000,000
Sub-bituminous	996,081,000,000
Bituminous	1,429,895,000,000
Semi-bituminous	56,569,000,000
Semi-Anthracite and Anthracite	22,423,000,000
Total	3,444,552,000,000

Water Power, Important but Insufficient

Practically all the developed water power of the United States goes into the generation of electrical energy. The total electrical energy generated in 1941 in the United States was 168 billion kilowatt-hours, of which hydroelectric energy was 51 billion kilowatt-hours, or 30 per cent of the total. Reliable estimates place the feasible harnessing of falling water for hydroelectric energy at 220 billion kilowatt hours per year in this country from supplies available 90 per cent of the time. This would very handily take care of our present electrical demands if it were properly placed.

Inasmuch as water power is nonexpendable this might seem at first glance to take care of most of our demands, but that impression is misleading. A compilation of information on energy used in 1939 indicates that the mechanical and electrical energy consumed in the United States in that year was about 9,580 billion horsepower-hours, of which 226 billion horsepower-hours were electrical energy. Electric power accounted for only one forty-second part of the total energy consumed in the United States in 1939.

This suggests that water power cannot supply more than a small fraction of our total energy demands.

Miscellaneous Sources

Wood and wind have had a long and honorable history in the power picture of the past. But the wood supply, even if most efficiently utilized, is completely inadequate for nation-wide or world-wide energy demands. It is as if a couple of sling shots were used where large caliber cannon are needed. Wind has two major shortcomings: it is of too low a potential (not enough push to it, on the average) and it is too variable.

Waves and the tides have been surveyed time and again by power-hungry eyes. Wave motors and tidal mills have been built and used for practical purposes, to a

limited extent. They will work—just like a burro—when they are good and ready. They are of low potential, extremely variable, and not sufficiently well distributed to be important.

THE ROLE OF TECHNOLOGY

The foregoing is the substance of where we stand now in the world's energy supply, as I see it from the many data at hand. The situation is by no means desperate. It is not even unfavorable for the immediate American prospects, especially because of our very favorable position in coal. But the long-range worriers, the sociologically minded, and some physical scientists begin to knit the brows slightly even now. The inadequacy of energy supply in the future can be faced. Perhaps this problem can be solved, slowly and methodically. But the inequitable distribution of the supply over the face of the earth and among the masses of population should be a matter of no small concern when the international dignitaries sit down at the peace table—in the near future, we hope.

Whatever deals, exchanges, or compromises may be made to cope with the inequities involved, it is practically certain that no permanent or reasonable solution will be found until the scientists and technologists have had their day, at least as the power behind the throne. Their past accomplishments are worth looking at and a few suggestions for future activities might not be amiss.

Developments in Conservation

The natural reaction when future shortages are discussed is to turn the trend of thought to conservation. It seems that the average person thinks of conservation merely as non-use, but that negative, penny-wise-pound-foolish approach obviously does not solve the problems. Real conservation is wise and effective use. In the case of energy supplies this means improved efficiency in recovery and utilization. A great deal has been accomplished in the past on this score and the extent of effective activity should increase greatly in the future.

The fuel which is closest to American life is gasoline. Activities to improve efficiency of recovery and utilization during the past few decades make a very interesting and hopeful picture.

Getting All the Petroleum Out of the Ground

Even with the best production methods, over half of an original petroleum deposit is still in the ground after the well has apparently gone dry. The oil fills the interstices between the sand grains and also clings to the surface of the particles through the action of adsorptive forces. Getting all the oil out of even a limited area is analogous to sucking all the juice out of an orange, concealed in the center of a basket of rocks, with a long hypodermic needle. In the mid-continent fields oil flow is sometimes revived by "repressuring" the wells. In this process natural gas is forced into overlying strata. The opposite approach, forcing water under the oil layers, has been employed with some success, particularly in Pennsylvania. In some oil sands the structure can be opened up and the rate of oil flow increased by forcing copious quantities of 15 per cent hydrochloric acid solution to the bottom of the wells. All these things help—but not much. Mining the sands appears to be impractical, not to mention being very expensive. If someone will devise an inexpensive means of breaking the adsorptive forces between petroleum layers and the sand grains, he will, by this one successful technical advance, at least double the petroleum resources of the world.

Improved Production and Utilization of Gasoline

Petroleum out of the ground is not yet gasoline. Many complicated refining steps have to be accomplished before petroleum yields the final motor fuel. Only a fraction of petroleum normally ends up as some-

thing to put into the gasoline tank. Widespread utilization of cracking (heating the liquid to high temperature under high pressure, to break down the molecules of the complex compounds) has more than doubled the yield of gasoline and so has more than doubled the supply of motor fuel. In 1916 the average yield of gasoline per barrel of crude was about seven and one-half gallons; today it is about eighteen gallons per barrel. Now the polymerization of refinery gases into liquid fuels is beginning to come in, and is helping to extend further the life expectancy of petroleum reserves. Through the use of more and larger pipe lines, natural gas is being used much more extensively, and relatively little is now wasted. Such technical advances are a great factor in maintaining a liquid fuel supply.

These are striking advances, but more striking ones may be possible at the utilization end. No heat engine is an efficient device, if one judges efficiency in terms of the proportion of the potential energy of the fuel which is converted to useful work. This widespread inefficiency is inherent, for it is in a good measure due to the second law of thermodynamics, which cannot be repealed. But there are ways of improving the situation even if there is no chance of achieving perfection. Within the past few years the efficiency of aviation engines has been improved markedly by the development of high-compression engines and of high-octane (anti-knock) fuels to go with them. Automobile engines are beginning to catch up. Thus far increased size of cars and engines has just about kept pace with improving efficiency, so we still average only the traditional fifteen miles per gallon. But the after-the-war trend will probably be toward lighter cars and still more efficient engines, and the forty-miles-per-gallon standard-sized automobile is frequently discussed as entirely feasible. If this materializes (and threatened gasoline shortages will hasten the trend) a major victory in wise conservation will have been accomplished.

Economic pressure is the most effective means known for increasing efficient utilization of a commodity. The history of coal consumption in steam-electric generating plants is striking. In 1880 the generation of one kilowatt-hour of electrical energy called for the burning of ten pounds of coal. By 1900 the figure had decreased to five pounds; in 1918 to three and one-third pounds; and at the present time a power plant manager loses caste among his colleagues if he uses more than one pound of fuel per kilowatt-hour of electrical energy generated. That is conservation on the march.

Technological improvements such as these keep the long-time energy picture from appearing really gloomy, provided the scientists and technologists are allowed to retain a free hand to attack the problems in their own grubbing way. But no matter how much the efficiency of utilization is improved, the day of depletion is only postponed. The day will come when new sources of energy must be tapped, and it would be highly desirable to have some of the new sources available now for some of the less-favored regions of the world. There are several technical possibilities of new sources which are worthy of discussion. The panacea is not yet at hand but the possibilities are all interesting and some of them appear hopeful.

Shale Oil

In Colorado and other parts of the country are many billions of tons of oil shale which, when heated, yield from half a barrel to two or three barrels of petroleum-like oil per ton of shale. The estimated United States reserve is 92 billion barrels. The potential supply is equivalent to about five times the liquid petroleum in sight. It is enough to supply our motor fuel for sixty to eighty years, assuming all of the oil could be recovered from the shale and that our

needs do not increase. But mining or quarrying the shale, retorting it, and disposing of the waste cost effort and money. If the refinery cost of gasoline should double, shale oil might compete. We shall be supplied only by paying higher prices than at present.

Hydrogenation of Coal

Germany and, to a lesser extent, England are making fairly satisfactory liquid fuels by reacting hydrogen gas with low-grade coal. In the Bergius process, coal is introduced into a retort in the presence of any of several possible catalysts. The yield of liquid fuel of fairly good grade can be as much as 125 gallons per ton of coal processed.

The Fischer-Tropsch process uses producer gas (a mixture of carbon monoxide and hydrogen) which is made by the reaction of steam on coal or coke. At high temperature and pressure and in the presence of proper catalysts, carbon monoxide and hydrogen react to give a mixture of various alcohols plus some liquid hydrocarbons.

By 1939, Germany was producing synthetic motor fuel by these processes at the rate of 200 million gallons annually. That would fill a great many gasoline tanks, but it would supply the United States for less than a day and a half.

The experience of these two countries shows that it is possible to produce quantities of motor fuel from coal, but at a price. The cost of production is about twenty cents a gallon compared to the American cost of production from petroleum of five to six cents a gallon (at the refinery). This high cost might be lowered somewhat, but the prospects are that it will not go down materially. For a considerable period of time, at least, we could continue to drive our cars on motor fuel from coal, but we should have to pay dearly for the privilege.

Utilization of Current Vegetation

About fifty times as much energy is stored up in plant life on the earth in one year as man utilizes in that year. It might, then, appear that we could use trees, grasses, and shrubs for fuel, and thus solve the problem of obtaining energy. Close investigation makes that idea discouraging as far as the United States is concerned. The only annual crop available for fuel use in this country would be the cellulosic farm wastes. These wastes total about 260 million tons per year. But to supply our required 25 quadrillion B.t.u.'s would call for about 1,800 million tons—sevenfold greater than the supply, assuming every bit of the agricultural scrap could be assembled for use.

Bringing the forests into the picture would not help much. The standing timber in the United States totals about 400 billion cubic feet of good, honest wood. If we used it exclusively to supply our energy demands, it would last just about four years and no more. Our energy requirements today are of an entirely different order of magnitude than during the Revolutionary period.

The production of alcohol from farm products for motor fuel has been a political football all over the world. Thus far it has been unfeasible and uneconomic. The first unfavorable factor is that of cost. Although marvelous claims of low cost ("if we can only get going on a large scale") have been made, the evidence thus far indicates that production costs would be fifteen to twenty cents per gallon. If the production costs of petroleum products rise about threefold, then alcohol could come into the race on the price basis and supply part of the demand, but by no means all of it.

The acreage required to furnish the necessary fuel casts a pall of discouragement over any hopes of producing all motor fuel from farm crops. The 300 million acres under cultivation in the United States probably cannot be greatly extended without serious injury to our soil. The possibility of growing enough additional corn to meet the thirst of our automobiles seems

remote, until we can so improve agricultural practices as to get much higher productivity per acre.

High-producing sugar cane might seem to be in the running—a mere 40 million acres of good-yielding cane would satisfy the demand. That is about 30 per cent more land than lies in Louisiana. There is not that much sugar-cane land in the United States.

Alcohol from farm products is made by the fermentation of starch or sugar. If the microorganisms could be induced to ferment the cellulosic waste directly to yield large amounts of alcohol, the picture might be more favorable, but they do not seem to want to work that way. Relatively recent work, particularly at the Carnegie Institute of Technology, has shown that by proper control of basicity, temperature, and pressure, cellulosic material can quite rapidly be converted into liquid or solid fuels analogous to petroleum and coal. This may be a good lead to follow for part of our fuel supply, but thus far it is only a prospect.

Marine biologists, in the midst of their amazement at how much life there is in the sea, at times suggest that a variety of the more or less immobile small organisms—the so-called plankton—could well be cultivated in small bodies of water and would yield large quantities of energy in the form of plant and animal compounds. This would bring up many practical difficulties of utilization, but it still appears interesting. As far as I know, no active experiments have been conducted along this line.

DIRECT UTILIZATION OF SOLAR ENERGY

Thus far all this discussion of possible future sources of energy is really beating about the bush, for every source mentioned, with the exception of tidal power, actually goes back by some devious path to energy from the sun. Why not focus attention on the actual source itself and do away with middle man operations? Here is where we can really look to the scientist and acquire a warm feeling of security.

It would be the greatest bit of irony of all time if our much-vaunted scientific civilization should falter for lack of power, because the sun showers as much energy onto the earth in one minute as the human race utilizes in one year. It can be had for the taking, but the taking apparently calls for a good deal more cleverness than we have yet displayed.

The radiant energy reaching the outer envelope of the earth's atmosphere is 0.168 horsepower per square foot of projected area. In the latitude of the temperate zones, with normal weather conditions, about 0.1 horsepower per square foot of the earth's surface should be available. The energy falling on one square yard of roof would be more than enough to operate all the electrical household appliances, including light bulbs, of the average family—if it could be directly utilized. Most factories have sufficient energy falling on the roof to operate all the machinery in the place—if the management had enough ingenuity to capture it. Enough energy falls on about 200 square miles of an arid region like the Mojave desert to supply the United States.

One of the obvious possibilities for direct utilization of solar energy lies in photovoltaic cells such as the type made of copper oxide discs or of selenium. Thus far photovoltaic cells have operated with efficiencies of only about 0.5 per cent and have been very expensive. If someone can make revolutionary improvements in them, and can cut the cost of construction sharply, we might have something there. At present the prospects are discouraging but one hesitates to say that such utilization is forever impossible.

Quite extensive experiments have been conducted on the harnessing of the thermoelectric effects, the heat being supplied to bimetallic thermocouples by solar rays. This is in about the same state of development as the photoelectric cells, interesting

but of doubtful utility for the problem in hand.

The simple and obvious device of using focused sun's rays to heat up a liquid has been toyed with for a long time. Dr. C. G. Abbot, of the Smithsonian Institution, has a small solar power plant with revolving parabolic mirrors for which he claims an electrical energy production efficiency of 15 per cent. We shall have to do better than that if the sun's rays, which are not of very high intensity to begin with, are to be a practical energy source. It is not likely that the efficiency of a solar power plant, if it operates by steam generation, can be greatly improved.

Energy by Photosynthesis

The genesis of all our fuels rests on the chemical reaction of photosynthesis, whereby carbon dioxide and water combine, with the aid of solar energy and with chlorophyll as a catalyst, to give the chemical compounds of plants. The exact mechanism, the intermediate products, the mapping of the individual steps of photosynthesis are still matters of scientific dispute, but the effect can be represented by the over-simplified equation:

$$H_2O + CO_2 + \text{radiant energy} = HCHO\ (\text{formaldehyde}) + O_2.$$

Although it probably is not retained in any part of the process, the simplest possible carbohydrate, formaldehyde, might be thought of as the building block for all plant structure; whatever the steps, photosynthesis first produces simple sugars, which then serve as the basic material for the complex compounds of the plants.

These compounds are so much solar energy, for they can be burned or otherwise oxidized to release the potential B.t.u.'s stored therein. The burning of coal is, in effect, the releasing of a block of some ancient solar radiation.

In nature, the process of photosynthesis is highly inefficient as an energy-storing mechanism. Even in the case of the most luxuriant plants, the potential energy of the compounds formed is less than 2 per cent of the solar energy that fell upon the leaves. Chemists have become so clever in the field of catalytic reactions that they should be able to improve that energy-capturing efficiency by many fold.

What we should like to do would be to take some such simple compound as formaldehyde, formed with the help of radiant energy, put it in an electrochemical cell, expose it to oxygen, and thus reverse the above reaction and get back the stored energy as electrical energy. Perhaps all that is needed is a proper catalyst to complete the oxidation to carbon dioxide and water and get back all the stored energy.

It is a wide open field—this study of photosynthesis and oxidation. That is the reason it is promising. The systems that might be used would not necessarily be limited to organic compounds. It may well be that inorganic compounds offer the most hope. The satisfactory system would need to be one that is as light-sensitive as the chemicals on a photographic film; as easily reversible as a lead storage cell. If such a photo-chemical-electrical system can be developed, the problem of energy capture and storage might be solved. The storage of the energy would be simply that of storing chemical compounds. We are accustomed to doing the same thing with coal. Some day the photochemical approach to energy utilization will either be accomplished or definitely proved impracticable.

ATOMIC POWER, CONVERSION OF MATTER TO ENERGY

Nearly all the foregoing discussion has been with eyes to the sun as the original source of our energy, but even that is a form of evading the issue. Where does the sun get its energy? Sound theoretical considerations indicate that the answer is found in the conversion of mass into energy.

One of the results of the Einstein considerations was to focus attention on the relation between mass and energy. In the

last analysis mass is energy and energy has mass, and the one should be convertible into the other. The Einstein relation between mass and energy is the simple equation, $E=MC^2$, in which E is the energy in ergs, M is the mass in grams, and C is the speed of light in a vacuum (approximately 3×10^{10} centimeters per second).

Each gram of matter is the storehouse of 9×10^{20} ergs, or 2.15×10^{13} gram calories. The energy of combustion of a gram of coal is a mere 7,000 calories. Hence, if we could completely annihilate matter we should be able to obtain 3,000 million times as much energy as from the burning of the same weight of coal.

Spectroscopic and theoretical evidence establishes with fair certainty that the energy of the sun comes from the conversion of hydrogen into helium with a slight overall loss in mass and the release of tremendous amounts of energy. This cycle of events does not happen on the earth. We do not have the energy concentrations of the extreme pressures and the 20 million degrees C. interior temperature of the sun. At first glance it appears that we are never to have a successful Atomic Energy Development Company on the earth.

But there is a breed of man which thrives on intricate, difficult, and apparently unsolvable problems. Disintegration of matter intrigues the physicist. He will not let the idea alone. Although he has not yet devised a practical atomic disintegration process that gives a net yield of energy, he knows that nature has provided one on a small scale in the spontaneous but ordered disintegration of radium, which gives an overall, though sluggish, transformation of mass into energy, accompanied by a true transmutation of elements.

Just prior to World War II, a great deal of interest was aroused among the atomic disintegrationists by some research which indicated that one of the isotopes of the element uranium might be disintegrated by a controllable chain reaction and thus release great blocks of energy. The fate of this line of work will probably not be known until well after the war.

Intriguing as the energy-from-atomic-disintegration idea may be, it is probably not a good bet for solving our energy supply problems. It is fraught with so many difficulties and unknowns that it is a frail reed to lean upon. As the world becomes more and more conscious of the extreme importance of sources of inanimate energy, technical developments along the lines mentioned above will probably be forthcoming, and several of the methods may be utilized in different parts of the world.

THE IMPORTANCE OF PROPER DISTRIBUTION

If a train of freight cars drawn by a modern steam locomotive were completely loaded with the coal and water necessary to feed the locomotive, it could pull the train about 3,500 miles. Hence, if the coal and water of the United States were not well distributed, transcontinental travel by steam trains would hardly be feasible, for that represents the "zero payload" range. Large airplanes have about the same maximum range. The range for ocean vessels without refueling is, fortunately, much greater.

The difficulties of supplying fuel for the very extensive air cargo work in this war has brought the importance of the distribution of energy supplies into sharp focus. Transpolar travel by air has long been discussed and now that it might become a reality in the not distant future people are beginning to wonder about the fuel supply. Where is the aviation gasoline coming from for the great-circle fueling stops in Baffin Land? How about the points in mid-Africa, or the valleys of the Himalayas, or the northern wastes of Siberia? The fringe of land around the northern polar cap offers geological prospects for petroleum resources. These will probably be intensively investigated before long. Under the exigencies of war the isolated and out-of-the-way places are supplied with fuel by boat,

train, and pack train, but only at great expense and expenditure of human energy. Air travel can never rise to its inherent volume and importance in those regions where the fuel supply is dependent on complicated and expensive transport from very distant bases.

Air travel is but one of the multitude of energy-consuming activities of modern civilization. All modes of mechanical travel, of manufacture, of daily living in the modern sense call for a tremendous accumulation of potential B.t.u.'s and horsepower in some form or other. The pent-up peoples of the world are beginning to murmur about the opportunities they have not had. The murmur may soon be a growl and then a roar, and a new conflict of peoples will be in the making.

The problems of international living involve a great many items, many tangibles and intangibles. But one of the most important phases is that of natural resources, and of these the sources of energy probably take top place. If the scientists and technologists can devise feasible means of utilizing the various possible sources so that all who need it can have copious supplies of inanimate energy readily available, then a long step will have been taken toward providing the foundation of a truly orderly world.

PHYSICAL SCIENCE IN SENIOR HIGH SCHOOLS

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A COMMITTEE studying secondary education in the Pittsburgh school system recommended that a year's course of study in physical science be offered for "some pupils of grades eleven and twelve of the senior high school who are not expecting to go to college. . . [This course should include] some of the practical applications of principles found in chemistry and physics. The plan used in the development of biology from botany and zoology will indicate the method for preparing a course in physical science from chemistry and physics."

Acting upon the committee's recommendation, a course in physical science was outlined. The course is not intended to replace the usual chemistry or physics courses, but is to be less formal than either; more practical and interpretive; more descriptive, with many applications. Its purpose is to help develop understanding of materials of civilization and insight into certain scientific principles which contribute to good individual and community life adjustments.

The outline of the course in physical science is now in mimeographed form. It is still tentative. It is meant to serve only as a guide in pioneering this phase of the secondary school program of studies. This article presents excerpts from the outline, selected to indicate the underlying philosophy, the general content, and the kinds of activities considered desirable.

BASIC ASSUMPTIONS

Science is the best use of human intelligence to understand and improve the environment. The word *environment* includes all phases of the natural environment, "things and their forces" as well as "men and their ways." Science in the schools should be considered as embracing living experiences, methods of thought and action, attitudes of mind, and areas of knowledge, understanding, and insight.

The nature of modern civilization is such

that in conducting this course for high school pupils less emphasis should be placed upon purely factual material and more emphasis upon attitudes of mind, methods of thinking and working, and the social implications of these methods.

Education is the enrichment of life and the effective adjustment of the individual to his environment. The purpose of general education is to meet the needs of individuals in the basic aspects of living so as to promote the fullest possible realization of personal potentialities and the most effective participation in democratic society.

Science in a program of studies should help to provide for self-realization, proper human relations, economic efficiency, and civic responsibility. The accomplishment of these ends calls for:

Appetite for learning.
Controlled self-assurance.
Responsible self-direction.
Coöperativeness.
Social recognition.
Personal health.
Creativeness.
Esthetic satisfaction.
Vision.
Wide range of personal interests and mental resources for leisure time.
Optimum development of personality.
Guidance in choosing an occupation and vocational preparation.
Social sensitivity and responsible participation in socially significant activities.
Assurance of progress toward adult status.
Effective action in solving basic economic problems, including good workmanship, cooperation in correcting unsatisfactory conditions, and wise selecting and purchasing, and skillful use of goods and services.
Increasingly mature relations in home and family life, with associates of similar age, and adults outside the family.
A satisfying world picture and a workable philosophy of life.
Development of reliance on free play of intelligence in solving problems of human concern; reciprocal individual and group responsibility for promoting general welfare.

CONTENT OF THE COURSE

The selection of content for the course in physical science has been difficult because of the wealth of available material on the one hand and the lack of agreement by educators on the other hand. The sources of help consulted in determining content included:

Students' interests. Both controlled questionnaires and informal ones were used to discover these, as were studies made by other investigators.
Opinions of such service groups as the Rotary Club and the Lions Club.
Courses of study in physical science, both published and unpublished.
Books and magazines dealing with science for popular reading.
Books dealing with science education—

National Society for the Study of Education. *Thirty-First Yearbook, A Program for Teaching Science.* Public School Publishing Company, Bloomington, Illinois, 1932.

Brown, H. Emmett. *The Development of a Course in Physical Sciences for the Lincoln School.* Bureau of Publications, Teachers College, Columbia University, New York, 1939.

Progressive Education Association, Commission on Secondary School Curriculum. *Science in General Education.* D. Appleton-Century Company, New York, 1938.

This course is intended to help meet the needs of average boys and girls, primarily those in the noncollege group, by broadening their understanding of practical scientific problems which they are bound to meet in everyday living, and by developing some degree of confidence and skill in meeting and solving such problems in a somewhat scientific manner. To this end, emphasis has been placed upon the scientific use of that vast array of materials and energy resources which research has made available. This emphasis should also lead to some understanding of the importance, problems, and effects of scientific research —an understanding which is essential for effective living in the present world. A brief outline of the course content follows:

Area of Study One. Introduction—Understanding Science

Why study science?
What are the methods of science?
What is the nature of our physical world?

Area of Study Two. Using Home Materials Intelligently

How has science helped solve our problems concerning clothing?

How has science helped us solve our problems concerning foods?

How has science helped us solve our drug problems?

How has science helped us with our cosmetic problems?

How has science helped with our painting problems?

How has science helped solve cleaning problems?

Area of Study Three. Applying Electricity to Daily Living

What has man learned about magnetism?

How can electricity be generated?

How can electricity be made useful?

How can electricity be used to communicate over long distances?

Area of Study Four. Producing and Using Industrial Materials

How has science helped industry to use metals more effectively?

How has science helped to convert ordinary plant fibers into many useful products?

How has science helped in the development of vitally important plastic materials?

Area of Study Five. Conditioning Air for Greater Comfort

What scientific principles are involved in making and controlling heat?

How is heat energy of fuels made available and distributed with a minimum of waste?

How is air cooled and its composition modified for more healthful living?

Area of Study Six. Making Machines Work For Us

How are home tasks made easier through the use of machines?

How has industry used machines to make yesterday's luxuries today's necessities?

How does man control the natural sources of energy through the use of machines?

How have machines improved our methods of going places?

Area of Study Seven. Using Light Effectively

How has our knowledge of light energy been used to improve visibility?

How can we record our visual impressions for future use and enjoyment?

Area of Study Eight. Summary—Looking Forward

SUGGESTED ACTIVITIES

The suggested course in physical science will, no doubt, be of most interest and value in those classes where pupils are encouraged to do things, rather than to have things done for them. Consequently, a great many activities have been suggested. Some of them are standard experiments which have been done successfully by students, while a few are the product of the imagination of those who prepared the outline. It is not likely that all of the experiments suggested will be performed by any one group. Certainly some controlled experiments should be carried out, to indicate the methods of scientists in action.

In addition to activities of the standard-experiment type, some unsolved problems may attract the attention of pupils and teachers. Two examples are the problem of securing greater efficiency in the transfer of energy from fuels to mechanical devices, and the problem of improving transportation by the use of such vehicles as the convertoplane.*

Notebooks may be kept in whatever manner teachers deem advisable. Probably the method scientists use is most satisfactory. Their notebooks are usually both formal and informal, with notes that help the user fix facts or solve problems.

A motion picture projector should be a part of the physical science classroom equipment. A crew of well-trained student projectionists under the careful supervision of a teacher can render service both to the class and to the school as a whole.

More motion pictures are listed in the course outline than can be used profitably by any one group. Each teacher should select and use some, and should evaluate and report on those used, so that a list of films that have been found particularly helpful may be determined.

Pamphlets, charts, exhibits and other supplementary materials mentioned in connection with the course have all been inspected and checked for availability. Most of them may be obtained free upon request.

* *See* Wendt, Gerald. *Science for the World of Tomorrow*, pp. 106–109. W. W. Norton and Company, Inc., New York, 1939.

AN ILLUSTRATIVE AREA OF STUDY

To illustrate the kind of help offered to teachers by the outline of the physical science course, one area of study is reported in some detail. This area is entitled "Producing and Using Materials." For this area, the following desired outcomes of learning are listed:

Understanding some of the basic physical and chemical processes involved in developing and manufacturing an ever increasing variety of industrial materials

Appreciation of the importance of such metals as iron and aluminum in our community and a knowledge of some of the ways science has helped make them more useful

Better understanding of the vocational opportunities offered by industry in our community

Appreciation of the fact that natural resources are not inexhaustible and a knowledge of some of the substitute materials that have been prepared

Appreciation of the value of research and cooperation in improving old materials and developing new ones for industry

The content was developed with reference to the questions listed in the brief outline. Each of these questions was analyzed into subsidiary questions, called key questions, and for each subsidiary question several activities were suggested.

The first of the principle questions in this area—How has science helped industry to use metals more effectively?—was broken into three key questions. The questions and activities follow:

How do we get our metals?

1) Extract copper from copper oxide using charcoal as a reducing agent.
2) Using a mixture of charcoal, iron ore, and calcium carbonate, try to obtain iron. Improvise a stack and hot air blast.
3) Demonstrate the thermit reaction.
4) Make a diagram of the blast furnace, showing its operation and the materials used.
5) Prepare copper by the electrolysis of a water-soluble salt.

Why is steel said to be the backbone of modern industry?

1) Demonstrate the hardening and tempering of carbon steel.
2) Try to galvanize a strip of sheet iron.
3) Prepare a chart of various alloys of iron, giving approximate composition, characteristics, and uses.

How has aluminum become a servant of of industry?

1) Try to obtain aluminum from its oxide, according to Hall's method.
2) Starting with clay, obtain aluminum sulfate, then aluminum oxide, and then the metal. Explain why the method is not practical.
3) Prepare a chart showing the processes through which aluminum must pass to become useful, using specimens to illustrate when possible.
4) Demonstrate the effect of certain acids and strong alkalies on aluminum and give a list of precautions for its use and care.
5) Prepare a chart giving all the uses you can find for aluminum, as well as the metals with which it is mixed to make it possible to so use it.

The second principle question—How has science helped to convert ordinary plant fibers into many useful products?—was analyzed into two subsidiary questions, and again activities which might contribute to answering them were suggested.

How is paper made from cellulose?

1) Prepare a chart giving the names of processes for making paper; materials used, kinds of paper produced, and chief uses for each variety of paper.
2) Make a small sheet of paper.
3) Prepare an exhibit to show the

steps in the manufacture of paper and some samples of the paper made.

4) Collect several types of paper and apply the phloroglucinol test for ground wood pulp. Classify your samples for durability. (Reference: Sutermeister, Edwin. *Chemistry of Pulp and Paper Making.* John Wiley & Sons, Inc. New York, 1929.)

How has science helped make a "Dr. Jekyll and Mr. Hyde" out of cellulose?

1) Show by test tube reactions the fundamental steps in making rayon by each of the four major processes.
2) Prepare a report on the materials and uses made of cellulose and show how it might be considered a "Dr. Jekyll and Mr. Hyde" sort of substance.

The third question—How has science helped in the development of vitally important plastic materials?—was similarly treated, as follows:

How is glass made?

1) Heat a small amount of glass and blow into a bulb or draw out into a tube or rod. Prepare a sample card to exhibit materials used and products formed. (Reference: Howe, E. W. *Chemistry in Industry, Vol. I.* New York Chemical Foundation, New York, 1924.)
2) Demonstrate the method of imparting color to glass by using borax beads and metallic salts or melting clear glass and coloring in same manner.

Why is glass a valuable substance?

1) Prepare a list of different varieties of glass and the uses made of each.

How is rubber made to be useful?

1) Prepare a report on the history of rubber.
2) Prepare an exhibit showing materials used in making rubber as well as the steps in making an automobile tire.
3) Prepare a chart giving the various forms of rubber and uses for each.

How are the newer plastic materials "pinch-hitting" for nature?

1) Prepare and mold some Bakelite-like material. (Reference: *Science Leaflet,* vol. 14, no. 16.)
2) Prepare an exhibit and make a report on products obtained from milk.
3) Prepare a chart giving the names of as many new plastic substances as you can find, giving materials from which they are prepared and their possible uses.

In addition to the references given in connection with the activities, the outline included a bibliography, a list of pamphlets and exhibits, and a list of useful motion picture films.

BOOKS FOR CLASSROOM USE

Hausrath, A. H., and Harms, J. H. *Consumer Science.* The Macmillan Co., New York, 1939.

Wilson, S. R., and Mullins, M. R. *Applied Chemistry.* Henry Holt & Co., New York, 1939.

BOOKS FOR LIBRARY USE

Beery, Pauline G. *Chemistry, Applied to Home and Community.* J. B. Lippincott & Co., Philadelphia, 1926.

Beery, Pauline G. *Stuff.* Appleton-Century Co., New York, 1930.

Collins, A. F. *Science on Parade.* Appleton-Century Co., New York, 1940.

Furnas, C. C. *The Storehouse of Civilization.* Teachers College Bureau of Publications, Columbia University, New York, 1939.

Holmes, Harry N. *Out of the Test Tube.* Ray Long & Richard R. Smith, Inc., New York, 1934.

Leonard, J. N. *Tools of Tomorrow.* Viking Press, New York, 1935.

Reynolds, N. B., and Manning, E. L. *Excursions in Science.* McGraw-Hill Book Co., New York, 1939.

Wendt, Gerald. *Science for the World of Tomorrow.* W. W. Norton & Co., New York, 1939.

PAMPHLETS AND EXHIBITS

Aluminum Company of America, Pittsburgh, Pa. Materials on aluminum.

American Iron and Steel Institute, 350 Fifth Ave., New York City. Write for list of available materials.

Bakelite Corp., 247 Park Ave., New York City. Pamphlets on Bakelite.

Behr-Manning Co., Troy, New York. Pamphlets and exhibits on abrasives.

B. F. Goodrich Co., Akron, Ohio. Exhibit and pamphlets on rubber.

Central Alloy Steel Corp., Massillon, Ohio. Pamphlets on sheet iron.

Coors Porcelain Co., Golden, Colorado. Materials on porcelain.

Copper and Brass Research Association, 420 Lexington Ave., New York City. Pamphlets on copper.

E. I. Du Pont de Nemours & Co., Wilmington, Delaware. Pamphlets on Neoprene and other materials.

General Motors Corp., Detroit, Michigan. Pamphlet: "Metallurgy and Wheels."

Goodyear Tire and Rubber Co., Akron, Ohio. Pamphlet: "The Story of the Tire."

Hammermill Paper Co., Erie, Pa. Exhibits for sale. Write for details.

Plaskon, Inc., 2112–24 Sylvan Ave., Toledo, Ohio. Pamphlets on plastics.

Strathmore Paper Co., W. Springfield, Mass. Pamphlet: "Making Paper."

Tennessee Eastman Corp., Kingsport, Tenn. Pamphlet on Tenite (plastics).

Texas Gulf Sulfur Co., 75 E. 45th St., New York City. Pamphlets on sulfur.

SOUND MOTION PICTURES

Aluminum, Mine to Metal. (20 min.) Bureau of Mines.

Story of Neoprene, the Synthetic Rubber. (20 min.) Y.M.C.A.

The Fourth Kingdom. (30 min.) Y.M.C.A.

Trees and Men. (30 min.) Sound Masters, Inc.

SILENT MOTION PICTURES

Copper Mining and Smelting. (15 min.) Eastman.

Iron Ore to Pig Iron. (15 min.) Eastman.

Aluminum, Mine to Metal. (30 min.) Bureau of Mines.

Aluminum Fabricating Process. (30 min.) Bureau of Mines.

Lead. (15 min.) Eastman.

Making Glass. (14 min.) Henry Sazin.

Pig Iron to Steel. (15 min.) Eastman.

Rubber. (15 min.) Eastman.

Sand and Clay. (15 min.) Eastman.

Short Course in Paper Making. (30 min.) Glatfelter.

Tin. (15 min.) Eastman.

CONCLUSION

The outlined course of study in physical science was presented to teachers in June, 1941. Although no formal evaluation has been attempted, experience with the course permits two general conclusions. First, the work is interesting. Pupils' reactions and teachers' reactions alike have been generally favorable, sometimes enthusiastic. Second, more detailed suggestions to teachers are needed in order that pupil activities may be more effective. Activities should be varied; the course must not be allowed to become either a reading course or one in which manipulation is stressed to the exclusion of reading and class discussion. Activities should be so chosen and directed that they may aid in developing problem-solving abilities in real life situations.

War conditions modify high school courses; science teachers make adjustments quite readily. The War Department's Pre-Induction courses sometimes take the place of the physical science course. It is interesting to note that the same units are considered important in both the physical science course and the United States Government's courses.

THE GOAL OF EDUCATION IN SCIENCE

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WITHIN the traditions of secondary education are two aims: to prepare youth for college, and at the same time to educate for the development of personality and effective participation in social action. The first is the easier, but it has numerous drawbacks. School authorities have given lip-service to the goal of general education, but until recently they have been primarily concerned with the preparatory function and have favored a curriculum of subjects to be learned and examinations to be passed. In common practice only the boys and girls with highest competence in academic learning are encouraged to try for college, and many of these are strongly motivated by the desire for social approval that comes with attendance at college. It is now generally recognized that the development of personality can take place effectively only under conditions where initiative and practical judgment are much more encouraged than in the usual college preparatory curriculum. It is also generally recognized that young people should have a much wider knowledge and understanding of the world and its history than is afforded them through the study of standard subjects.

Educators are voicing in no uncertain terms the need for reforms favoring a system of education that is more appropriate than the old to the conditions of the times and especially to the ideals of American democracy. A report prepared for the American Youth Commission [1] points out that instruction with respect to the issues that confront communities and the nation must be given if the general populace is to be intelligent about those things; and that, since the large majority of young people do not continue their education beyond the secondary schools, instruction with regard to social issues cannot be postponed to the period of college attendance.

The conviction has grown that the various subjects of the curriculum should be brought into closer relationship with one another and that the educational activities made available to young people should be more effective in helping them to understand themselves and the world and to take their full share of responsibility for citizenship. The merits of these proposed reforms are generally recognized, and policy-making bodies have offered recommendations on how they should be carried out.

One report,[2] prepared as a background for revision of secondary education in the State of New York, proposes that young people should be aware of the problems likely to confront them when they leave school; that they be equipped to deal with these problems; and that they have the knowledge, interests, and attitudes which will help them to become "acceptable citizens." It proposes also that they acquire the interests, knowledge, and attitudes which will enable them to take advantage of their individual talents and abilities. The conclusion from this report and others is that in any revised program of secondary education a prime essential must be a curriculum focused directly on the kinds of competence that young people out of school will surely need.

The foregoing considerations define the goals of science teaching. Scientific knowledge is at hand and is being used in indi-

[1] *What the High Schools Ought to Teach*, p 10. The Report of a Special Committee on the Secondary School Curriculum. American Council on Education, Washington, D. C., 1940.

[2] *High School and Life*. The Regents' Inquiry. McGraw-Hill Book Company, Inc., New York, 1938.

vidual and group action. Out of scientific endeavor have come the materials used in the life of today and ideas for a new interpretation of the world. These ideas are affecting, for good or ill, our economy, government, occupations, morals and ethics, religion—in fact the whole of life and society. Science is an integral part of the world today and pervades all living. The goal of science teaching is to help young people realize that science is as much a part of their personal lives as it is a part of their physical world.

THE BROAD FUNCTIONS OF EDUCATION IN SCIENCE

The necessary functions to be recognized in adapting science teaching to the practical needs of youth have already found widespread acceptance in theory and to some extent in practice, and are reflected in curriculum organization and in classroom teaching in many schools. Some of the considerations basic to curriculum planning for the kinds of competence young people will surely need may be summarized briefly: The issues and problems of everyday life are broad and, in part, unpredictable. Accordingly, the student's knowledge of science should be broad; it should encompass and relate the content of the several special sciences. It is recognized in theory and increasingly in practice that young people should be helped to relate their study of science to their own practical experiences, and to understand and set up, as part of these experiences, conditions necessary for scientific generalizations. They should have practice in the basic methodology of science: for example, classifying, measuring, defining concepts and units, and using statistics. As a result of such practice they may learn that precise formulation and communication of principles are essential when the methods of science are employed. Given opportunity and enc .ragement to deal under guidance with problems that arise out of their own practical experience they will have opportunity to learn to use scientific methods in dealing independently with the issues and problems of everyday living.

Examples of the science understandings important in the issues and problems of youth may be stated broadly. First, young people should become aware that application of scientific principles means learning about material things and phenomena through firsthand experience with them. They should be enabled to understand conditions of personal and social health. They should be helped to realize that national and world economy depend upon natural resources and technology. They should learn how science may help them to free themselves from feelings of fear and guilt and from fraud, deceit, and superstition in all their experiences—for example, in commercial, political, or religious contacts. They should be helped to build up for themselves a coherent picture of the world as it is revealed by science.

Reports on the experiences of thoughtful teachers have shown that senior high school students are well aware of issues and problems that exist in the community. They are aware of and they lament the low health standards and the unfavorable conditions under which men work. They recognize and want to deal with issues and problems pertaining to use of resources and to religious, racial, and national conflict. Obviously, developments in science and technology affect the manner in which these issues and problems are to be handled. Conclusions concerning them drawn without an awareness of the impact of science are certain to be inadequate and erroneous. High school students are mature enough to consider these issues. The school must give them opportunity to develop the scientific and technological understandings that have bearing on the way these issues may be settled. Only through practice in dealing with issues and problems, will youth learn to recognize the major problems confronting society and learn of the general applicability of science

and scientific methods to practical problems of all kinds.

NEEDS OF YOUTH

When the influence of science and technology on present day society is analyzed and broken down into specific effects, the needs of young people become evident. Students now in secondary schools are confronted with many large issues, not only during the period of their development, but also during the years when they will make up the adult population.

How may the resources of science be used in the maintenance of good health and physical fitness for all? In order to use the resources of science to this end, young people must have knowledge of the existence of pathogenic bacteria and viruses, and an understanding of the relationship of these organisms to the illnesses they cause. This understanding is essential to intelligent social action on the part of all citizens, not of just the few. Without it people are at the mercy of charlatans and ignorant, though possibly honest, practitioners in matters of vital concern to individuals and communities. Young people should be familiar with the physiology of their own bodies so that they may guard against nutritional and other bodily defects, such as cardio-vascular weakness and hernia and defective eyes, teeth, ears, and feet. Understanding of the effectiveness of control of these matters by social action, together with knowledge of the extent to which sufferers from bodily defects are dependent on society and on the more fortunate members of their immediate families, will furnish the incentive to act to maintain good health and physical fitness for all.

Have we the resources and the technological competence for a high standard of living in our own nation and throughout the world? If young people are to be competent to deal with this question, their world-view must include a concept of scientific agriculture—soil culture and plant and animal culture. Increased agricultural production has been accomplished through plant- and animal-breeding and through improvement of the soil. Each of these two processes augments the other in making possible production of foods for a continuous and expanding economy, the limits of which are certainly far beyond even our present wartime production.

Young people must also have information about energy resources and must understand how they may be used. Although petroleum is still abundant, there are reasons for demanding more efficient utilization of it. Our tremendous reserves of coal may be processed to serve any practical purpose. It is undoubtedly possible to extend water-power installations enormously. To every question concerning energy resources the answer seems to be the same: there is plenty of energy to be had, if man is wise enough and ingenious enough to make good use of it.

The need for metals in a continuing and increasing economy can be met similarly. Our supplies may be more efficiently used. Techniques for separating metals from plentiful low-grade ores may be improved. The use of metals from scrap may be increased. Substitutes may be developed.

This question about resources and technological competence raises many issues that will call for decisions on the part of young people now in school. The Commission on Education for Morale of the American Association of School Administrators reviews data[3] which show that in 1941 a family of four required about $2100 a year to live in an urban community in modest comfort and on an adequate diet. It also presents data to show that 65 per cent of American families in 1941 were living on an income of $2000 or less. As many as 16 per cent were living on $500 or less. People have had little opportunity to learn to use science in dealing with such

[3] *Morale for a Free World.* American Association of School Administrators, Twenty-second Yearbook. National Education Association, Washington, D. C., 1944.

problems. Education for competence to deal with them is unquestionably education for morale. Zeal, hope, and confidence will attend the activities of men when each individual works with the realization that he is contributing to the enrichment of the world and with assurance of reward in accordance with his effort. Resources, work, creativeness, pleasure and recreation take on new meanings when they are defined out of the background of a scientific and technological view of the world. The earth's resources are at the disposal of our youth. The beginnings of science and technology are a heritage to be passed on to them through education. These, when refined and extended and intelligently applied, will enable them to create from this wealth an abundant life.

Is the public educated to select and use materials so as to encourage production of good products and discourage inferior products? The consumer can learn how to distinguish good merchandise from bad and to label as fraudulent the false claims that are sometimes made about the quality of goods and services. He can learn to protect his own commercial interests and he can contribute to stabilization of our economy through selecting, and thus encouraging the production of, good quality materials. He can learn to support and to work with agencies, both governmental and private, that are set up to protect his interests as a consumer.

How may working relations be set up among people so that the best that is in each individual may find expression? For their consideration of this issue it is important that young people understand the biological nature of man. They should know the strengths and weaknesses in themselves and others and the factors that condition these qualities. They should know about the history of man and the relations of present races and nations to those of the immediate and the remote past. Conflicts among races and other groupings arise out of errors in understandings and in false teachings. These conflicts encourage hatred and destroy morale. The schools should help youth to carry on scientific studies and thus gain competence to dispel unfounded fears, erroneous beliefs, and false teachings about themselves and others and to build as part of their world-picture a comprehensive, scientific view of man.

Are young people learning to live in a world in which ways of life are based more and more upon interpretations derived from firsthand observations of nature? The eagerness to inquire about the nature of things and to seek the answer through examination has furnished the reservoir of ideas that has been used, not only in increasing our competence in production, consumption, and physical fitness, but also more and more in our thinking about the nature of the world and man. Scientists have learned a great deal about the things and forces of the world. The history of the world and of life has been learned from study of observable phenomena. Men have learned about the nature of matter and energy and how to use them. Ideas concerning the nature of things are derived and are accepted as valid, or rejected, on the basis of experience. Many of the older ideas about matter, energy, and life inherited from the past through old books are being rejected because they are not consistent with experience. The further promotion of these outmoded ideas serves only to confuse the youth who are being educated for the responsibilities of today. Science as method and content is a heritage of young people, and is furnishing the raw materials out of which they are increasingly building their conceptions of values; and there is an increasing tendency among people to define values only in terms of that which may be experienced. This reinterpretation of the world and this notion that values are valid only if they may be experienced provide motives for change in religious outlook, for revised standards

in morals and ethics, and for reforms in civil government. Science is not apart from the world. It is woven into it and affects all our institutions. Obviously, young people may experience confusion and emotional disturbance as they discover that scientific conclusions about life are inconsistent with some widely held beliefs. In their confusion they need education to help them guard against superstition and deceit when making decisions.

These specific questions and issues are illustrative of those encountered in the world today; if secondary education is to be concerned with the immediate needs of youth it must take account of them.

THE EDUCATION OF TEACHERS

It is not sufficient to attempt educational reforms merely by initiating curriculum changes, for these changes cannot be effective unless they are made so by the teachers. Just as the preparatory function associated with a now outmoded theory of mental discipline has, in the past, largely dominated the program of the high school, so has it largely dominated the program of teacher education. Teachers have been urged to learn a fixed body of content—to specialize in a field—and have in turn taught that fixed body of content to the young people who make up their classes. Teachers under this system tend to become automatons passing on to others what was previously passed to them. It is said that "the teacher must know what he is to teach." The implication of this statement is that he must know his subject and that he need not know anything else. A familiar response to questions that are really meaningful to youth is: "Your question does not come in my field; we deal with the fundamentals." This heritage of established practices is obviously inadequate for the broad functions of education in science, yet it must be recognized in recommendations for reforms.

Not all the difficulties to be encountered are to be found centered in the teachers. It is the common testimony of competent, resourceful teachers that they are not permitted to exercise originality outside the narrow restrictions of fixed curriculum patterns and rigid examinations. There is pressure from parents to make children learn the fundamentals and measure up to standards. Administrative officers and supervisors are caught in the groove that has been worn by traditional plans and standards. The teacher who wishes to do anything different is likely to be rated a nuisance. Consequently, teachers learn to stay in the groove and do as they are told. Evidence of the damaging effect of this system of education is in the observation that many teachers confess to deriving but little stimulation from their work. They accept it as something to be done and, like workmen in a factory, seek their satisfactions in life from activities pursued outside their vocation.

Trends are in evidence, however, to encourage the exercise of initiative and judgment on the part of teachers in dealing with their students. These trends will be favored more and more as teachers are educated to assume responsibility for independent action. When the schools demand such teachers, our colleges for the education of teachers will use their resources to supply them.

Teachers may be educated to take account of the activities of young people and of problems and issues they face. They will learn to consider the facts and generalizations that summarize experience pertinent to the problems and issues of youth. They will learn to take account of the attitudes of people toward problems and issues encountered in community life. Obviously issues do not take meaning from isolated experiences, but from the total of activities in which men are engaged. Hence, it is not enough that the high school teacher shall know the subject he is to teach; this is only one of the several competencies that he must have. In addition, he must be

competent as an individual, as a citizen, and as a teacher.

As an individual and a citizen, the teacher should have an understanding of cultural groups and of the variations in institutional forms of past and present society that have brought these cultural groups into being. He should have a working knowledge of scientific research and of the potential relations of science and technology to social organization in America. Finally, he should develop, insofar as he can, a consistent conception of life, and within this cultivate worthy leisure-time activities from which aesthetic satisfactions may be derived.

As a teacher, he should understand himself and his students, their parents, and others in the community. He should know enough about educational philosophy to enable him to plan his work in the light of sound values. He should be in command of the techniques of good teaching and be able to evaluate his work as a teacher in terms of its contribution to his students' growth in competence.

The teacher of science is not only a person, a citizen, and a teacher, but he must also be a scientist. Professional education must take account of all these aspects of his life. Science teachers must learn enough facts and generalizations to build for themselves a scientific view of the world and they must have practice in using the content and methods of science in resolving issues. To help youth do these things, they must be able to do them themselves. *The teacher must in truth know what he is to teach.* Obviously a program of narrow specialization will be inadequate.

The general pattern of knowledge to be acquired by the science teacher may be suggested here only briefly. It will include the structure and development of the physical universe, the organization of the living world and how it has changed through time, and the interrelations of living things. It will include the work of man in using energy and materials, including living things, under modern conditions. This general pattern must include, finally, men's thoughts about themselves, about society, and about the world.

The program of studies through which the prospective teacher may build up this pattern of knowledge will not be rigid. It will provide specialization within the special fields, as in physics or chemistry or biology, but work in the special field will be seen as a part of, and related to, the general pattern. The program is not to be viewed as one to be completed before graduation, but as a plan of work and study to be continued throughout life, with revisions as need arises.

In summary: The aim of our secondary schools is to educate for the development of personality and for effective participation in social action. Educational reforms look to better realization of this aim. Curriculum revision, to be effective, will have a threefold function. It will give direction, first, to the work in the schools; second, to the thinking and planning on educational matters that goes on in the school community; and third, to the programs for education of beginning teachers and for the re-education of teachers in service. The goal of education in science is to help young people and their teachers to make science as much a part of their lives as it is a part of their world.

SCIENCE IN THE ELEMENTARY SCHOOL AND THE AIR AGE

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THE rapid development of aircraft is changing the child's world as well as that of adults. In the past, the child was interested in airplanes largely as a means of travel and as a motif for much of his building and construction work. He spent hours of leisure time with father, brother, or the boy across the street making and flying miniatures of various types of aircraft or in making toys modeled after different kinds of planes. He liked to visit the airport and watch the great planes arrive and depart. He left reluctantly when dinner time came.

Today, in the midst of a great world war, the situation is different. Now, father, brother, or the man across the street may be a navigator, a pilot, a bombardier, or perhaps may be working in a great bomber plant. Even mother and sister may be making airplane parts. Because of such a background of experience, the child's questions or concerns about aircraft are born of intense feeling. They are of importance to him as well as to every other person in his world. He hears them discussed by the radio reporter and at the dinner table; he reads about them in magazines and the daily papers; and he talks about them with his companions at school and at play.

Out of such experiences arise many problems, questions, or sometimes only curiosities, which present new situations to the teacher. The teacher must do something about them because they form a large part of the child's interest, experience, and thinking. It is her responsibility to help him work out his problems, answer his questions, and satisfy his curiosities. That is, she is concerned with helping him to be more intelligent in his thinking and more secure in his reaction to situations in which aircraft are important. Since many of the child's concerns require science for their understanding, the teacher who knows children and their environment will be sensitive to their particular science needs and will adapt the science work to meet them.

At first thought, it may seem as though a new course is necessary to help children understand airplanes and the unique problems they present. An examination of outlines of science used in elementary schools indicates that units are already included that relate to the large areas of science important to a lay understanding of aircraft. However, a study of the outlines shows the need for a re-evaluation, leading to re-emphasis, redirection, and modification by strengthening and extending materials already included and by adding new materials where necessary. Emphasis must be placed where it is of first and immediate importance. This point of view may be illustrated by a survey of basic understandings relating to aircraft and by a survey of the outlines of science used in elementary schools.

SCIENCE UNDERSTANDINGS RELATING TO AIRCRAFT

For example, a study of flying in relation to the atmosphere points out many science implications important in satisfying fundamental concerns of children. Some of these implications are the following:

The atmosphere is essentially a mechanical mixture of gases surrounding the earth.

The atmosphere is composed of several gases which are nearly constant in amount together with water vapor and dust.

Man lives at the bottom of the ocean of air.

One half of the air by weight lies below 18,000 feet and 97 per cent below eighteen miles.

Weather changes take place largely in the lower layer of the atmosphere, the troposphere, and make flying hazardous.

There are no clouds in the stratosphere because there is practically no water vapor in it.

In the lower stratosphere there is a region of little atmospheric change.

Conditions in the lower stratosphere are considered to be the nearest approach to the ideal for flying.

Air is compressible.

Air exerts pressure.

Air pressure decreases as one ascends in the atmosphere.

Air expands when heated and contracts when cooled.

Moving air produces a force called wind.

The temperature of the air in the troposphere falls on the average of about one degree Fahrenheit with each 300 feet of elevation.

Temperature is measured by a thermometer.

THEMES IN SCIENCE OUTLINES FOR DETROIT ELEMENTARY SCHOOLS

An understanding of this partial list of items is dependent upon knowing fundamental air, water, and temperature relationships. Much of such basic information is included in outlines of science. For example, in the outlines in science for Grades 1–6 used in the Elementary Schools of Detroit, the following themes are suggested in the various units concerned with air, water, and temperature:

Air is all about us. It fills the schoolroom and the out-of-doors.
Air takes up space.
Air cannot be seen.
The effects of moving air can be seen and felt.
Moving air is wind.

Air and water are important environmental factors.
There is water in the air in the schoolroom. It cannot be seen or felt.
There is water in the air out-of-doors.
Sometimes the water cannot be seen or felt.
Sometimes the water can be seen and felt.
Water from moist surfaces evaporates into the air.
Water may be a liquid, gas, or solid.
The thermometer tells how warm things are.

Water in the air comes from various sources, such as moist surfaces, plants, and animals.

Air presses against objects with force.

Wind does work for man.
It runs windmills that pump water for stock and for irrigation and runs saw mills and grist mills.
It moves sailing vessels, ice boats, and gliders.
It blows foul air away.
Kites will fly only in wind.

There is a continual circulation of water from the earth into the atmosphere and back to the earth again. Specific atmospheric conditions produce specific weather conditions.

Weather is a determining factor in the daily life of man.

There are instruments that tell man about weather.
The thermometer measures temperature.
The barometer measures air pressure.
The anemometer measures wind velocity.
Rain and snow gauges tell how much rain or snow has fallen.

Weather maps and weather signals tell man in advance what weather he may expect.

The U. S. Weather Bureau provides an important service. Weather predictions are important to fruit growers, shipping companies, airplane pilots, and in predicting floods.

Weather superstitions and misconceptions represent early attempts of man to explain weather.

SUGGESTIVE MATERIAL FOR THE FIRST GRADE

To illustrate how a concept of air may be developed with children on the first grade level, a summary of a unit in the Science Outlines of Instruction, Detroit Public Schools, follows:

Theme

There is air all about us. It fills the schoolroom and the out-of-doors.

Air takes up space.

Air cannot be seen.

The effects of moving air can be seen and felt.

Moving air is wind.

Suggested Activities

To provide opportunity for experiences that will help children develop an understanding of air as something that is all about them, that cannot be seen, and that

occupies space, experiments such as the following may be performed:

1. *Push an inverted "empty" water glass into a battery jar partly filled with water.*

   Examine an "empty" water glass noting that it is dry inside and that nothing can be seen or felt in it. If there is anything in the glass, it must be the same thing that is in the room other than books, chairs, tables, and the like.

   Invert the "empty" glass and hold it in a vertical position over a piece of cork floating on the surface of the water in a battery jar. Push the glass down over the cork into the water and make the following observations:

   The cork floats on top of the water at the mouth of the glass.

   Almost no water goes up into the glass.

   Water rises in the battery jar when the inverted glass is pushed down into the water in the battery jar.

   Raise the glass and observe the following:

   The cork floats on top of the water at the mouth of the glass regardless of how far the "empty" glass is pushed into the water.

   The water level in the battery jar lowers as the glass is lifted and rises as the glass is pushed into the water.

   Raise the glass from the water in the battery jar. Feel the inside of the glass, noting that it is dry. This shows that water did not enter the glass.

   Repeat the experiment a number of times, noting that each time the same result is secured.

2. *Push an inverted "empty" glass into a battery jar partly filled with water and tip the glass slightly.*

   Push an inverted "empty" glass into a battery jar partly filled with water, as was suggested in the above experiment, and then tip the glass slightly, noting bubbles escape. *Return glass to a vertical position* and note that water has entered the glass. *Repeat experiment a number of times.* From such experiments and directed observation, children have a background for making the following conclusions:

   Water could not go into the glass because the glass was full of something that could not be seen or felt.

   When bubbles of what was in the glass came out, there was room for water to go into the glass.

   The teacher and children will decide through discussion that the something in the glass which could not be seen or felt is air similar to the air in the room.

   Repeat this experiment in different parts of the room, in the school hall, and out-of-doors, noting that in each case the same results are secured. Suggest that pupils try the experiment at home and compare results with results of experiments performed at school.

3. *Put air into a toy balloon.*

   Further experiences showing that air occupies space may be secured by putting air into the lungs. Then, put the air in the lungs into a toy balloon noting that the balloon enlarges when air is put into it and decreases in size when the air in the balloon is let out.

4. *Show that moving air can be felt and that the effects of moving air can be seen.*

   To understand that air is something that can be felt when it is moving and that the effects of moving air can be seen, give opportunity for experiences such as the following:

   Hold the hand vertically in front of the face, emphasizing the fact that air is all around the hand but that it can neither be seen nor felt.

   Move the hand quickly from side to side noting that air can be felt as it is pushed against the face.

   Fan the face with a paper or a palm leaf fan noting that air can be felt as it is pushed against the face and that the moving air moves hair and clothing.

   Open a window or door leading to the out-of-doors. Note that some articles in the room move. Try to find out why they move.

   Blow a feather or a milkweed seed into the air. Try to find out what you gave out when you blew the feather and what you had to do as soon as you had blown the milkweed seed or feather.

To gain an enlarged understanding of the effects of moving air, make observations, such as the following:

Air from ventilators pushes against the hand.

Leaves of plants, strips of paper, and pieces of string are pushed by moving air from ventilators.

Moving air out-of-doors pushes against objects causing them to move.

Moving air cannot be seen but it can be felt and its effects upon objects can be seen.

Moving air out-of-doors is called wind.

To add to the understanding of air, do things such as these:

Make paper windmills and watch the wind move them.

Make kites and watch the wind carry them into the air.

Play with toys that are run by moving air.

Make a collection of pictures showing wind moving sailboats, iceboats, and windmills.

Make a collection of pictures of aircraft flying in the air.

Put a bottle in a jar of water and watch the water enter the bottle as bubbles of air escape.

Pour water out of a narrow necked bottle filled with water.

MODIFYING AND STRENGTHENING OUTLINES

In a similar way, information about the atmosphere is emphasized in the various units of science for grades 1–6. This suggestive material about the atmosphere serves as a basis for helping children understand aircraft and their importance in peacetime as well as in war. However, in order to answer the new problems, questions, and concerns brought by the rapid development of aircraft, it is necessary that the outlines be changed so that they will provide the types of experiences that will satisfy the child. This means reconsideration of the materials in the outlines in terms of the child's concerns. New emphases may be necessary to strengthen the old materials, perhaps new materials must be included.

For example, in a fifth grade unit entitled, *The United States Weather Bureau provides an important service in predicting weather,* emphasis is placed on the following basic understandings relating to weather:

The Weather Bureau has means of taking and recording readings of air temperature, pressure, and humidity, and direction and velocity of wind.

On the basis of data gathered by the Weather Bureau, weather predictions are made.

Basic information of this kind is essential in answering children's questions about flying, such as these which were actually asked by fifth grade pupils:

Why does the pilot need weather information when he leaves the airport?

What weather information should the pilot have before he takes off?

How is weather information gathered for fliers?

How does the pilot obtain weather information during flight?

Why must the pilot know a good deal about weather?

What does a crew in an airplane need to know about weather?

To answer questions such as these, basic information is not sufficient. It must be extended, and new materials must be added. Answers to such questions involve also an understanding of the effects of weather conditions on airplanes.

The study of the atmosphere in relation to aircraft is only one of a number of areas that might have been used to illustrate science implications that are important in satisfying concerns of children in relation to flying. Other areas that might have been used are light, sound, electricity and magnetism, strategic materials used in making airplanes, and the effect of flying on the human body.

It is clearly, then, the obligation of the teacher to direct science work in such a way that it suggests situations in which children have opportunity to gain science understandings that will help them live more satisfactorily and securely in an air age. It is also her duty to organize materials in such a way that opportunities are provided to help develop and use democratic ideals, such as tolerance, cooperation, honesty, respect for another's point of view, and scientific ways of thinking, working, and acting. That is, children should have opportunities to develop and use patterns of behavior, of feeling, and of thought essential to a people living in a democratic society in an air age.

STILL A TEACHER OF SCIENCE

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ONE of the things that bothered me most when I first took my present job as Extension Nutritionist was the thought of how little my education in science and science teaching would affect my work as an Extension Nutritionist. I had been enrolled in departments of natural science during the major part of my school life, had had several years' experience teaching high school science, and had taken graduate work in science education. My worry was not that this preparation would be wasted, because I am one of those who believe that even a little understanding of how things work is a tremendous advantage for life in these times. But real concern came with an analysis of the Extension Nutritionist's job as one where neither cells nor elements are discussed, where no law of Newton is ever "demonstrated," and where objective evaluation is an impossibility.

Extension work is chiefly adult education and, in Vermont, homemaking is taught to organized groups of rural women by county home-demonstration agents. Nutrition programs are planned through state-wide conferences of rural women, home-demonstration agents, and the state home-demonstration staff. Subject materials and teaching plans are organized by the state nutritionist, who is then responsible for training and assisting agents to hold meetings with their groups. In addition, the nutritionist holds training and demonstration meetings for groups of local, volunteer leaders who then present these materials to women's groups. Another phase of her job is holding occasional demonstration meetings directly with local groups. Thus, her programs are presented at three different levels of complexity, but all are designed to reach average homemakers.

The subject matter of nutrition, as we must deal with it, involves rather limited vocabulary and concepts, and almost none of it is demonstrable. Consider the difficulties of carrying malnourished rats from county to county! It soon became very clear that neither the subject matter nor the teaching devices I had learned would be of much help in the immediate contacts of my new job.

An acknowledged goal in Extension teaching is the development of skills, and since I came in just prior to the "Food Will Win the War" proclamation, my problems were those of food preservation. We are great savers, up here in Vermont, and canning is no new story to most of our rural homemakers. It is not at all unusual to have a homemaker report that she has put up a thousand jars for winter eating. It has been that way ever since the last war when canning was first taught by public agencies. So the problems are not so much those of instigating a wide-spread program of preservation as those of correcting faulty techniques and thereby reducing food spoilage and increasing vitamin conservation. For in spite of their certainty of knowing how to can, and in spite of favorable storage temperatures, women admit to a rather high percentage of spoiled produce. Also, so much progress in food science has been made in the last twenty years, that many techniques taught during the first World War are no longer recommended.

For example, the technique of sterilization was evidently emphasized by early canning demonstrators. Women use the word frequently and are quick to assure any questioner that they "sterilize" everything in canning. Perhaps their understanding of a sterilization process has been lost, or perhaps they were not taught very well, but whatever the cause they often fail to comprehend what sterilization means

and implies. To most women, sterilization can be accomplished by washing jars and lids in soapy dishwater, rinsing and scalding them. "Scalding" is a process of pouring hot water over the articles. A discussion of sterilization reveals that there is no hesitation about washing jars in which food has spoiled along with the others, no suspicion about using a soiled dishcloth, no doubts but that scalding water completes the process and that jars may be set aside to wait for packing without harm to their "sterilized" condition.

In cases where canning methods involve adequate processing of the food after it is packed in containers, poor sterilizing techniques can do no harm, but the open-kettle method of canning is still a common procedure and is recommended for certain pickles, relishes, preserves, jams, and jellies. These products do not often spoil, even if they are packed in unsterilized containers. Probably the acid of pickles and relishes is their safety factor. Sweets are usually poured while very hot; if not at their boiling temperatures, at least while still as hot as 212 degrees F., and they contain a high percentage of sugar. Both conditions make for safety against spoilage. However, fruits and vegetables processed in an open kettle are not so well safeguarded. To explain these facts of microbiology so they are understood is a real challenge.

Closely allied with techniques for sterilizing jars are those of adequately processing packed produce. The United States Department of Agriculture recommends processing by flowing steam or in a boiling water bath for fruit juices, rhubarb, and all fruits including tomatoes. Processing at higher temperatures dependent upon steam pressure is recommended for low-acid vegetables and for meats. These recommendations and their associated time tables are based on research and are considered safe for all sections of the United States. However, climatic conditions of humidity and temperature have made it possible for Vermont housewives to practice other processing methods with reasonable success. Probably our summers are too damp to foster spore formation of microorganisms. Our extremely cold winters may kill many bacteria, yeasts and molds which are free, and prevent their growth in canned products.

Consequently, processing meats and vegetables in a water-bath, or vegetables and fruits by the open-kettle method is often successful, even though the length of the processing period is shorter than recommended. Some women can rhubarb and cranberries by packing the uncooked food, covering it with cold water, and sealing the jars. And it often keeps!

The conditions of Extension teaching prevent recourse to demonstration experiments. It just is not possible to apply laboratory techniques in teaching the public the causes of canned food spoilage and nutrient loss. Much of the education is carried on by means of printed leaflets, newspaper articles, and radio presentations. Both state and county personnel hold demonstration meetings for women's groups, sometimes in public utilities' rooms and home economics laboratories, but more often in Grange halls, church basements, and private kitchens. The mechanical difficulties of laboratory teaching are almost insurmountable. In the issues of sterilization and food spoilage, it has appeared efficient to teach by other methods.

In any formal statement of reflective thinking or of the "scientific method" of solving problems, the first step is recognition that a problem exists. The approach to canned food spoilage problems is, therefore, simple, inasmuch as individuals and surveys both report spoilage losses. An ingenious agent can usually help her group to analyze and solve the situation by referring to their experiences in allied fields, and by explaining enough microbiology and thermodynamics to supplement their infor-

mation. Where pertinent and reliable statistics are available, they can be used to great advantage.

It must be admitted that, in practice, this logical process of problem solving occasionally breaks down. Food packed in contaminated jars does not always spoil, and it is sometimes difficult to make clear that climatic conditions and storage temperatures are responsible for the food's keeping, rather than adequate sterilizing or processing.

Sometimes illustrative materials can be prepared. For instance, the contents of a contaminated jar will show definite signs of spoilage if held at a temperature of 110 degrees F. for twenty-four hours. An agent can prepare such jars to illustrate the faults in common techniques of sterilization. A scheme for demonstrating the temperatures of various processing environments and of internal jar temperatures is to use a maximum thermometer, likening it to the clinical instrument with which most people are familiar. Another scheme which helps to develop a skill and may contribute to better understanding is the use of a steam thermometer inserted in a pressure canner. Most pressure equipment used in Vermont has a Bourdon dial gauge which registers pressure with a bimetallic strip. If accurately adjusted, this gauge measures internal pressure, but is an indication of internal temperature only when steam replaces air in the canner. Having a steam thermometer inserted in the lid of a demonstration canner is a convenient way to teach techniques of exhausting air.

A state program of testing pressure gauges has brought a further challenge to educational methods. When the women have had successful experience by processing at boiling water temperatures, and are offered only authoritative research as evidence of better conservation by pressure processing, it becomes increasingly difficult to prove the need for testing pressure equipment. It is sometimes necessary to warn them of possible explosions, or—less tragically—of corn caramelization.

Teaching techniques of preparing foods for freeze-locker storage has been somewhat simpler than teaching techniques of canning. One reason may be that this form of home preservation is relatively new, and people are anxious to follow techniques which will make their own frozen products meet the standards they have learned to expect of commercially frozen foods. Another reason may be associated with the fact that owning locker space is still something of a luxury to Vermonters, and only those who are more progressive-minded have made the investment. The attitude of a group which attends a freezing demonstration is perceptibly different from that at a canning demonstration.

The effect of quick freezing at 20 degrees below zero F.—the formation of very short ice crystals and consequent retention of the product's moisture and original texture—is explicable in terms of our sub-zero blizzards of fine snow. Then, too, it is known that creatures slaughtered and hung out to freeze in very cold weather make better eating than if frozen slowly. Enzymatic action, oxidation, and dehydration are processes difficult to explain but fairly easy to illustrate. The ripening of beef, discoloration of cut apples and potatoes, and drying out of uncovered foods in a refrigerator are all familiar examples, if not entirely understood. That enzymes are responsible for conversion of sugar to starch and for the destruction of ascorbic acid, and that the action of these enzymes can be stayed by proper blanching techniques, are facts for which authorities and their experiments must be quoted. Recommendations for moisture-vapor-proof packaging must also be based largely on the findings of research. But before locker patrons have had some experience with substandard products and come to recognize that preparation techniques may be responsible, there is little opportunity to apply the principles of scientific education.

Home food dehydration has been neither popular nor specially recommended in Vermont. With canning as successful as it is, and freeze-locker facilities rapidly increasing, there is little justification for promoting an inferior preservation method involving new equipment and skills. In rural areas drying corn and apples has long been practiced. Sun-drying is not very practical, but these products can be dried indoors successfully. The corn is usually cooked first to prevent souring, but apples are seldom pretreated. Old-fashioned sulfuring depends rather too much upon equipment and supplies not common in modern farm living, and besides, dried apples are supposed to be brown!

So much for the development of skills and understandings. There are others not here mentioned, but with food preservation and conservation the principal part of our present program, these are among the most prominent.

Teaching appreciations and desirable attitudes by means of Extension education in nutrition has many challenges. Concepts of scientific research and conclusions still bear some aspects of the supernatural, and without greater understanding there can be little real appreciation of scientific methods. Consequently, much use is made of descriptions of scientific research, together with references to familiar observations. Sometimes it is possible to demonstrate a bit of research. Blanching of all vegetables before packing and processing is recommended partly because of the saving in space. It is very easy, in a canning demonstration, to pack blanched and unblanched beans, process both samples, and show comparative results.

The development of attitudes which are scientific in that they are critically evaluating is a phase of the extension program particularly exemplified in nutrition. There are so many controversial issues and unsolved problems in its field that women can easily be taught to question the source and recentness of information. Such teaching seems most successful when attempted by both example and precept. Perhaps the natural caution attributed to Vermonters is a factor in that success; probably their contacts with information from conflicting authorities contribute to it. New England is a region of small states, in most of which several different educational agencies, as well as commercial and magazine organizations, are active. There has been little unanimity of information from the various sources, and this circumstance fosters an intellectually critical attitude.

The principles of food preparation and nutrition and their applications in everyday living are probably responsible for much of the curiosity and interest with which their teaching is received. Important contributions are also made by wartime emergencies and the National Nutrition Program. But without the constant emphasis of pragmatic teaching, these other factors would not be sufficient to maintain attitudes of active interest and curiosity.

It has been my attempt to show how the aims of science teaching have become the goals of Vermont's nutrition program. Generalizations and examples of methods of science education have both been used toward realization of those goals. The next step should be an evaluation of achievements in our program. However, I have not found satisfactory objective means of evaluation. Subjective means are readily available in the form of personal and reported observations, but these means alone are not sufficient evidence to be acceptable. If a program in nutrition has as its function the changing of behavior patterns, an objective method to make progressive recordings of those patterns should be employed in evaluation. Until such a method is developed, I cannot rightly claim that my teaching is effective, but by reason of the goals I recognize, the subject matter I deal with, and the methods I employ, I do claim to be, still, a teacher of science.

USING RADIO AS A TOOL IN SCIENCE INSTRUCTION DURING THE WAR PERIOD

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Cleveland Public Schools

RADIO has served education in Cleveland since 1925. From that year until the autumn of 1938 experimental educational broadcasts were used over cooperating commercial stations in the area. Results of this extended period of experimentation showed that radio had good possibilities in the field of public education, and that these possibilities might best be realized through the use of a broadcasting station owned and operated by the public school system. Six years of broadcasting by WBOE, the Cleveland School Station, have established the conclusion that radio is definitely a useful tool in education. Radio programs planned and produced by school people for school use may be employed either to broaden or to intensify instruction. Similarly, by careful planning and much trial and error, it has been established that the scope of effective supervision may be widened through radio broadcasts.

RADIO LESSONS IN ELEMENTARY SCIENCE

For ten years, since September of 1933, radio lessons in elementary science have been going into every elementary school in the city. The fact that, year after year, all schools have elected to receive these broadcasts is indicative of their appeal and value, both to pupils and to teachers. We believe that these are lasting values and that they serve the needs of children in a world at war, as well as in a world at peace.

Why have these elementary science broadcasts been so worth while? In the main, three factors have been responsible for the success of the lessons: first, the interest inherent in the material itself; second, the method of preparing the scripts and teacher-aids; and third, the variety of techniques used to promote dynamic learning situations both during the broadcast and later.

It is not necessary to dwell upon the first reason. Every person who has taught elementary science to children, by any method which encourages pupil activity, knows that holding their interest is no problem. The Cleveland radio lessons in science teach a portion of each unit suggested by the course of study and at the end of each semester test the basic understandings which have been taught, so that teachers and pupils alike consider them an integral part of their weekly program in science. Since these units have previously been developed with children and along the lines of the expressed interests of thousands of children at their age level, and since the basic understandings are built upon the foundation of earlier learning, there has been no difficulty in maintaining interest.

But the preparation of the radio lessons is no simple task. One year in advance of the broadcasts to the city schools, the radio teacher and the supervisor plan the phases of each unit to be presented over the air during the ensuing year. Then the radio teacher writes the script for a lesson, and broadcasts it via Station WBOE to different types of schools. The principals of these schools listen to the lesson and observe the pupil reaction. Later these principals meet with the radio teacher and the supervisor to suggest needed revision. Following this conference the lesson is rewritten, broadcast to other schools, and criticized again.

For the teachers who are to receive the lessons the radio teacher also prepares a mimeographed handbook consisting of:

Questions to be considered in the lessons.

Materials, such as supplies for experi-

ments, slides, or books, to be used during the broadcasts.

Suggestions for following up the lessons.

Suggestions for additional activities.

Bibliographies for teachers and pupils.

Because of careful preparation and constructive criticism, it has been possible to plan learning situations of so many types that there has been no tendency toward standardization of teaching procedure. The classroom teacher has been able to observe and at the same time to participate in so many demonstrations of good teaching techniques that the quality of all her teaching has been improved. She has seen how good questions, well-planned pupil activities, and skillfully directed experiments can stimulate her pupils to think more logically. She has been shown how to use books and visual aids effectively. Organization of supplies, equipment, and subject matter has been made easier, and, as the radio teacher has suggested possible plans for the week, the classroom teacher has actually been relieved of some out-of-school work.

By these methods the services of the supervisor have been multiplied many fold. Radio lessons not only make it possible for the supervisor's influence to touch every school every week, but they also help to free her time for participation in many other activities connected with science in the community.

Because the objectives and resultant outcomes of elementary science function in both peace and war, the aims and content have not had to be altered materially because of the war. However, many applications to situations and needs induced by the war are being emphasized. New units pointing toward the future are being developed; former learnings are being given new significance. For example, we are at present preparing lessons for fifth-grade classes. One unit is called, *Why Does the Weather Change?* This develops the reasons why forecasting the weather is so important during wartime and why the ability to interpret factors relating to weather is so necessary to those on the home front. Stimulated by the radio teacher to establish their own simple weather stations, the pupils are attaining a deep respect for the meteorologist, as they find that forecasting the weather requires much knowledge.

The subject of conservation is also being given a new significance by the war. The discussions and suggested activities are motivating many projects to conserve vital war materials, and, what is perhaps more important still, the lessons are pointing out the necessity for redoubled efforts in conserving soil, water, trees, and birds. One interesting project, which is an outcome of studying the need for conservation, is the cleaning up and planting of a gully along the railroad track in the vicinity of three adjoining schools. The children want the ravine to present a beautiful appearance to the boys leaving Cleveland for service!

The regular broadcasts given by the supervisor of school and home gardens to the children of the upper grades have a new significance. The children are learning how to plant and care for a small garden so that they may definitely contribute to the supply of food for the family.

A new unit, which is still in the stage of classroom experimentation but which will soon be written for radio presentation, is concerned with the uses of aircraft in war and peace. This unit, a very popular one with boys and girls, looks into the future, beyond the present when the airplane is being used as an agent of destruction, to the day when some of the boys and girls now in elementary school will be using it as a common means of transportation.

Perhaps one of the most worthwhile services which the elementary science program is attempting to render during these difficult wartime years is that of providing many leisure-time activities. With parents preoccupied or out of the home, the children need something constructive to do. Whether the child is enjoying trees or watching birds, collecting insects or work-

ing in the garden, playing scientific games or cooperating with other children in projects of conservation, he is well occupied. Elementary science, via radio or the classroom teacher, can make a real contribution to the child's total adjustment to the modern world.

BROADCASTS TO JUNIOR HIGH SCHOOLS

The urgent need for an intensified pre-induction program of instruction in science has been a major factor in shaping science broadcasts in the junior and senior high school fields during the war period. Health has been emphasized in weekly broadcasts to junior high school science pupils. During the two-year period 1940–1942 experimental health broadcasts were conducted in cooperation with the Education Committee of the Cleveland Academy of Medicine. A plan was worked out whereby medical men with special interests and training in certain fields were brought to the studios of the school station to answer pupil questions in these fields, and to present a variety of aspects of the case for building and maintaining good health. Since September, 1942, these programs have emphasized the importance of health in winning the war. An objective of each program is to point up at least one activity in which the pupil may participate in the home or community. These activities are related to personal and community health, and are indicated or implied in titles of broadcasts. Some of the titles are: "Rabies—A Year-Around Threat"; "Getting Along With People"; "The Common Cold"; "Exercise, Fatigue, and Rest"; "Protecting the Food Supply in Cleveland"; "How Hospitalization Serves You." Some programs of special war timeliness and importance have been repeated each semester. In all cases the program is recorded in advance of the broadcast date, and is repeated nine times on the scheduled day in order that pupils in each period of the school day may have opportunity to hear it. The use of recordings enables the busy physician to participate in the program at a convenient time.

Each science teacher receives an announcement and study guide several days in advance of the weekly broadcast. This sheet lists the topic, the names of the people who will appear on the program, the questions which will be answered, technical or scientific vocabulary terms which will be used in the broadcast, and a selected bibliography of current magazine articles, pamphlets, and book references related to the subject. The materials in the bibliography are always available in the Youth Department of the Main Library and in various neighborhood and school branch libraries. Appropriate charts and diagrams are included with the weekly sheets to teachers in some instances. Classroom activities following the listening period vary considerably with group I.Q. averages and with the amount of correlation which is possible between the subject of the broadcast and the unit of regular study which is under way at the time. Types of follow-up activities include pupil reports and discussions on bibliography readings, consideration of individual pupil and family experiences related to the topic of the broadcast, and projection and discussion of slides or educational motion pictures which develop other aspects of the subject. Listening in all cases is optional, and utilization and follow-up activities are determined by the needs, interests, and time available with individual teachers and class groups.

Weekly "log sheets" are received by WBOE from each school. These serve primarily as a continuous check on quality of reception in classrooms, but also indicate the number of classes which listen to each program in each school. Listening is by no means universal, and supervisory staffs hold to the point of view that optimum use of broadcasts is most likely to occur when listening is not required.

An evaluation committee of teachers from several junior high schools meets regularly with members of the radio and science supervisory staffs. The evaluation

committee serves the function of interpreting pupil interest, reactions, and needs to those who are charged with the preparation and presentation of the broadcasts. The committee's recommendations constitute the major factor involved in making up the schedule of programs to be broadcast. The wartime health broadcasts to junior high school pupils are, of course, not of immediate importance as pre-induction training. They may be of considerable value, however, in helping point the way to useful pupil activities in wartime.

PROGRAMS FOR SENIOR HIGH SCHOOLS

Pre-induction science teaching at the senior high school levels has concerned itself with giving the pupil scientific background which will enable him to cope with the occupational problems of military service. Electricity, mechanics, communications, and aeronautics are fields which have been indicated by military authorities as of greatest importance for pre-induction emphasis. Hence, in September, 1942, a program of wartime broadcasting for senior high school science pupils was inaugurated to include materials in these pre-induction areas. During the first semester of the 1942–1943 school year the program was given over entirely to broadcasts in the field of aeronautics under the general title, "So You're Going to Fly." Authorities in the community were brought to the school radio station to discuss topics such as: "Commercial Aviation Since 1925"; "Flying 'No See' "; "Flight Training of Army and Navy Cadets"; "Research in Aviation"; "Civil Air Patrol Activities"; and "Advances in Airplane Manufacturing." The experts who discussed these and other topics in broadcasts to senior high school pupils were obtained through the cooperation of the aviation editor of the Cleveland *Plain Dealer*. Two pupils selected from high school speech classes interviewed the aviation authorities. Prior to each weekly broadcast the aviation editor and a photographer from the newspaper accompanied the two pupils to the place of business of the expert who was to speak and answer questions on the program. The newspaper carried pictures and a news story from the industrial or occupational setting related to the topic of each broadcast. Thus some of the industrial processes and essential war activities of the community were brought directly to high school pupils in the classroom. The news stories and pictures served to build interest on the part of pupils and teachers, and also as an intelligent form of interpretation of wartime school activities to the public. The interest thus created, plus the fundamental educational significance of the materials involved, set a record of almost universal listening in senior high school science classes.

During the semester following this initial effort at using radio as a tool of science instruction in wartime, a series entitled "Wings and Waves" was broadcast. These programs were divided equally between aviation and communications topics. Interest was maintained at a high level on a selective listening basis; that is to say, individual broadcasts were pointed up especially for class groups in which the radio materials would correlate closely with regular classroom activities.

During the entire 1943–1944 school year programs for senior high school science classes have been broadcast under the series title of "Science and the War Industries." Mechanical, electrical, and aeronautical topics of pre-induction significance have been emphasized for class groups which are dealing with subject matter in these areas. Examples of weekly topics are: "Precision Aircraft Instruments"; "Use of the Automatic Gyro-Pilot"; "Applications of Electronic Research"; "Electroplating in Wartime"; "Critical Metals in the War Industries"; "Storage Batteries at War"; and "Synthetic Rubber Today." The practice of bringing men on the job in industry into the classroom through the facilities of the school radio station has been continued.

Much the same procedures as already

indicated in connection with the health broadcasts to junior high school science classes are followed with the senior high school programs. The weekly announcement is made up in the same way to include name of speaker, questions to be answered, vocabulary, bibliography, and appropriate diagrams or charts in some cases. Classroom activities following the period during which the broadcast is heard are somewhat more standardized, in view of the fact that the recommended practice of selective listening usually brings the broadcasts to groups which are dealing with broad subject matter areas related to the topics of the radio programs. An evaluation committee of senior high school science teachers meets regularly and serves approximately the same functions as already indicated for the junior high school evaluation committee.

Industrial firms have shown a real desire to cooperate in producing these programs. In almost every case top-notch authorities have been made available to present an authentic program and point of view to the pupils. Scripts are prepared well in advance of the date for each broadcast and are approved by the authority who is to make the broadcast, as well as by the office of science supervision and the radio production staff. Without radio few if any pupils would be able to share the experience and knowledge of the men on the job in industry. All broadcasts, in both the junior and senior high schools, are fifteen minutes in length, and all broadcasts are repeated for classes in each period of the school day.

SUPPLEMENTARY PROGRAMS

The radio activities indicated up to this point constitute the major part of the science broadcasting program. Another part consists of rebroadcasts. The Columbia School of the Air "Tools of Science" program is recorded each week and rebroadcast on a more limited schedule for supplementary listening in any science classes which may find the topics in this series of importance in relation to the regular classroom activities which are under way. Science programs recorded from the University of Chicago "Human Adventure" series are also rebroadcast on a limited schedule for supplementary listening in classes where the materials are pertinent.

A rather highly-specialized type of broadcast, which has proved valuable for some science classes as well as for a considerable number of clubs and other school groups, has dealt with the basic radio code materials approved by the Signal Corps for training purposes. These basic code records have been broadcast on a late afternoon schedule in order to make them available for any groups or individuals in the school who may be interested.

The demand for an intensified program of instruction in science and mathematical subjects in wartime is well established. Those in charge of classroom programs in these fields have found it desirable to investigate new teaching procedures, as well as to re-examine various practices which are accepted as meeting the needs of peacetime instruction. Educational institutions, professional organizations, and many thousands of individual teachers have, in the broad view, cooperated as a unit in stepping up instructional procedures and results obtained in the fields of science and mathematics teaching. The growing success of our war effort, the increasingly smooth operating efficiency of our technically trained military forces, and a variety of other indications point to the conclusion that considerable success has been achieved in teaching the "exact sciences" to both inductees and pre-inductees.

Radio is only one of various tools which are being used to intensify science instruction in schools during the war period. It is believed that there is considerable justification for the point of view that an educational radio station may be a very valuable tool in such a program.

YEAR-ROUND GARDENERS

VIRGINIA E. BANNING
Edison School, Detroit

EDISON Elementary School has a flourishing Junior Garden Club. Any child in the school district who is interested in gardening may become a member. A member is required to:

Present written permission from his parents.
Work out a diagrammatic plan of his proposed garden.
Prepare his garden plot for planting.
Plant and care for his garden.
Harvest his crops.
Prepare his garden for the following year.
Care for his tools.
Keep a record of his garden in the form of a notebook or scrapbook.

In other words, he must be an active gardener.

The location of the school is especially fortunate for gardening. It is situated in a residential district in which nearly every home has a garden. This makes it possible for practically every child to have his own plot at home. These home gardens serve as a laboratory for the garden work in the school.

Gardening is an integral part of the science program in the school. In the science classes, the children consider various types of experiments and garden activities. Some of these activities are as follows:

Selecting a garden plot in relation to soil, light, amount of time and space available for gardening, and the age of the gardener.
Planning a garden with consideration of varieties of vegetables that are most nutritious and that are disease-resistant; color, fragrance, and height of the flowers desired; the kinds of plants that are satisfactory for successive planting and for companion planting; and the amount of each kind of seed that will answer the needs of the particular family interested in the garden.
Studying different types of soils, testing backyard garden soils, and finding out how to make soils more fertile.
Preparing soil by proper spading, raking, and fertilizing.
Testing seeds to find out their viability.
Planting seeds such as those of cabbage, tomato, pepper, and eggplant in boxes or cold frames for early out-of-door planting.
Planting the garden with attention to depth of planting and the space between rows.
Cultivating the soil as a way of killing and controlling weeds, of conserving water in the soil, of enabling water to penetrate the soil readily, of helping to aerate the soil, and of improving the appearance of the garden.
Learning to identify and control common garden weeds in different stages of their growth.
Identifying harmful insects and learning how to control them by use of stomach or contact poisons.
Learning to care for garden tools by proper cleaning, repairing, and storing.
Harvesting produce at the appropriate time.
Storing, canning, and preserving surplus produce.
Collecting and preserving some kinds of seeds for the following year.
Transplanting garden plants for indoor bloom.
Cleaning the garden in the fall by removing and burning infested dead organic material, by spading the soil.
Making a compost heap.
Mulching perennial plants that need to be mulched late in the fall.

A close relation is maintained between the home plot and the school garden program, which makes some kind of out-of-school supervision of gardens necessary. During the school year, the science teacher is assisted in this supervision by mothers active in the School Parents' Club and by members of the Garden Division of a community Club. During the summer months, the supervision is entirely a community project under the direction of these two local groups. Their members visit each of the home gardens at least twice. The visitors have two purposes—to offer helpful suggestions and to judge the gardens. They select from among the gardens carried to completion (seventy-nine last summer, of ninety-four started) the fifteen or twenty best. These gardens are then visited by three expert judges who have not been working actively with the children. Each

garden is judged on the following five points:

General appearance.
Degree of freedom from harmful insects and plant diseases.
Evidences of good garden culture as indicated by general care, cultivation, and watering.
Succession of crops as a means of furnishing a continuous supply of produce and assuring full use of the garden plot.
Evidence of a carefully developed plan as indicated by choice of location, straight rows and paths, and a planting scheme of tall and short growing plants.

For judging, the gardens are grouped according to the grade level of the owners. Prizes are awarded for the three best gardens in each group. The prizes consist of American flags, science books, war stamps, and gladioli bulbs. The bulbs are donated each year by a man in the neighborhood who is interested in children and in stimulating young gardeners. The other prizes are bought with money given by the two cooperating community groups.

When judging is completed, an assembly is held at school in honor of the members of the Junior Garden Club. At this assembly, a film about gardens is shown and prizes are awarded both for the best gardens and for the best garden scrapbooks in each of the three groups of young gardeners.

Each September, a School Garden Festival is held in the school gymnasium. The program for the Festival is worked out cooperatively by the children, the science teacher, and a representative of the community garden club. An outline of the general plan and schedule of the most recent Garden Festival follows:

EDISON SCHOOL GARDEN FESTIVAL

8:00–9:00 A.M. Entries made and placed.

Directions: All entries must be grown in home gardens. Quality, not quantity, is desired. Exhibitors shall not make more than one entry in any one class. All children in the school including the Junior Garden Club members are invited to participate.

12:00–3:00 Festival open to visitors. Parents are invited to attend.

Vegetable Section

CLASS I. Vegetable arrangement suitable for a table decoration.
CLASS II. Specimen vegetables—at least three of any one variety.
CLASS III. Any unusual vegetable.

Flower Section

CLASS I. Miniature arrangement up to six inches in height.
CLASS II. Large arrangement of garden flowers.
CLASS III. Arrangement in any animal or figurine container.
CLASS IV. Arrangement for a teacher's desk.
CLASS V. Specimen bloom.

Seed Section

CLASS I. Any vegetable seed collection.
CLASS II. Any flower seed collection.

Miscellaneous Section

CLASS I. Artistic arrangement of gourds.
CLASS II. Specimen gourds.
CLASS III. Any unusual or odd exhibit.
CLASS IV. Any potted plant.
CLASS V. Any cactus.

The week before the Garden Festival takes place, copies of the program and entry blanks are distributed to all children in school who wish to participate. The program is discussed in each science class and suggestions are worked out for exhibiting garden products to best advantage. The children know that their specimen tomatoes, for example, will be judged with all other specimen tomatoes and that the more uniform they are in size, shape, and color, the greater the chance they will have of winning a prize. They know that when the program defines a miniature flower arrangement as being up to six inches in height, the judges will not consider a bouquet of flowers holding their heads up eight or ten inches. The children realize, too, that quality counts rather than quantity, and that a bouquet of a few excellent flowers gracefully arranged is more beauti-

ful than a great many flowers crowded into a bowl.

The week before the Festival is a busy one. Parents and teachers are asked continually for advice. They keep many secrets as to what the children are going to enter and how large and beautiful their vegetables and flowers are. Bright and early on the morning of the Festival, the children bring their entries and entry blanks properly filled out. Teachers and members of the cooperating adult clubs direct the planning of the entries. There were 317 entries in the 1943 Festival. To make judging impartial, all judges selected are parents and garden experts who have not worked with the children exhibiting, and all entry blanks are so placed that only the child's age may be seen. After the entries are judged and ribbons awarded, all eight hundred children in the school visit the Garden Festival.

After the close of the 1943 Festival, the exhibits and general plan of the Festival were discussed. During this discussion many problems concerning exhibits were raised, such as:

- Why did Norman's cabbage win first prize?
- Why didn't Betty's marigolds win a ribbon?
- What can we do next year to grow better vegetables and flowers so that they will win prizes?

Certain changes were suggested for next year's Festival:

- Eliminate the Seed Section, because there seemed to be little interest in seed collections and the table space is needed for other entries.
- Add a section on insect pests in the garden.
- Add a section on garden scrapbooks which are a record of the work of individual gardeners.

Suggestions were also made concerning exhibits that might have been included, as follows:

- Parts of plants eaten for food—root, stem, fruit, flower, leaf, and bulb.
- Types of preservation of vegetables and fruits for winter use—canning, pickling, preserving, freezing, storing in natural condition, drying, and salting.
- Diseases of common garden plants.
- Weeds in relation to the garden.
- Garden soils.
- Common fertilizers.
- Garden tools.

The general discussion raised problems for further study in the science classes, such as:

- What are the characteristics of a good vegetable or fruit: for instance, of a tomato, cabbage, bean, carrot, or beet?
- What makes some vegetables more nutritious than others?
- How can we prevent insect pests from living in gardens through the winter?

The children's comments showed that they were beginning to understand the value of home gardens. Their remarks included the following:

- We got a lot of fresh vegetables and fruits from my garden.
- My garden saved money and ration points, too.
- Because I had so many fresh vegetables in the garden, we didn't have to use gasoline to go to the store.
- It was lots of fun working in my garden.
- I worked awfully hard in my garden, but it always made me feel good.
- I didn't get enough tomatoes from my six tomato plants so next year I'm going to plant twelve.

In addition to a realization of the importance of gardens, the children gained many understandings and skills necessary for successful gardeners. The satisfaction they derived from their gardens stimulated them to plan immediately for next year's planting. With the cooperation of parents, this planning was carried on in school during the fall and winter months. The children have become year-round gardeners.

BRINGING SCIENCE TEACHING UP TO DATE

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THE nation's needs recently emphasized by the war made it imperative for teachers and educational administrators to revaluate the content of present courses. As a result, some courses have been revised and in other cases new courses have been added to curricula. This is true for high schools, teacher-training institutions, and colleges. At the same time, scientific research has resulted in the development of many new devices and products which are helping to win the war. Science teachers are brought face to face with the questions: How can recent developments in science be understood, assimilated, and utilized on the fighting fronts, on the home fronts, and in the post-war period? What changes in our methods and standards of living will be involved?

In our schools, we are attempting to teach the principles of science as they apply to living today, yet many students and adults merely take for granted the radio, the automobile, the airplane, and other applications of science which have raised our living standards. To a certain degree, at least, this condition is understandable. But students, teachers, and laymen should be stimulated to think along the lines of new problems, and to make the best possible adaptations for living during the war and in the post-war world. In many schools no radical departures are necessary to accomplish this end.

BIOLOGY IN THE NEWS

New developments in science can easily be used in teaching scientific principles. These developments are often reported as news items and as articles in current periodicals. There have been many recent reports, for instance, which may be used in connection with the study of algae and fungi in high school biology. One such report from reliable sources stated that the Germans have set up establishments along the coast of Norway to obtain and prepare certain sea weeds (algae) for food. Similar reports reaching us from Japan tell of the use of sea weed for food. Sea weeds contain certain substances needed by the human body.

The group of plants known as molds (Phycomycetes) may not have seemed attractive to high school biology students, and until recently laymen have found no reason to be interested in it. Textbooks have discussed molds as being destructive and also as imparting flavor to certain cheeses. But recent research has placed new values on at least one of the plants of the mold group, *Penicillium notatum*. The discovery that this mold produces a substance useful in the treatment of certain diseases—even to the extent of saving human life—has attracted world-wide attention.

Naturally a number of questions arise immediately. Among them are these: "Where do these molds grow best?" "Should they be kept in a warm or cool place, dark or light room, dry or damp air?" "How would one get them started?" These questions lead to simple experiments and to general discussion of the conditions under which fungi grow, get their food supply, and reproduce.

Elements of morphology, physiology, and ecology are involved in even a simple discussion of these questions. And that is as it should be. As we understand the simple structure of a mold plant, we can better grasp how it functions, gets its food, and reproduces. This information will

help us understand the influence of the environment on the organism. Obviously, algae and fungi are important groups of plants, and people in all walks of life are rapidly coming to recognize them as an important part of our environment.

INCREASING OUR SUPPLY OF FOOD

Other phases of biology which are brought to our attention, especially during wartime, are those related to the problems of food and nutrition. These include such topics as Food, New Uses of Plants and Animals, and Plant and Animal Breeding. One very definite problem concerning food was and still is the problem of increasing the available supply. An attack on this problem involves an educational program designed to reach farmers, gardeners, and the urban population. This program includes some new applications of the basic biology, chemistry, and physics in familiar courses.

Hundreds and thousands of pupils and parents, during the past season, were actively concerned with at least some of the following:

- Planning a plot for planting
- Testing soil or having it tested
- Problems of drainage, water supply, and irrigation
- Selecting the proper kind of fertilizers
- Studying the culture for certain crops
- Selecting crops in terms of deficiencies in supply
- Testing seeds (germination tests)
- Climate and weather conditions for the area
- Protection from plant diseases (sprays, etc.)
- Protection from insect pests
- Methods of harvesting
- Methods of storing and preserving food
- Preparing soil for the next season

This list is incomplete, but it serves to illustrate activities and problems which may be treated in science courses. People's interest in victory gardens offers an opportunity to revitalize work in biology.

THE PHYSICAL SCIENCES AND WAR NEWS

To realize the part chemistry has in this war one has only to look at the news reports. He will find such topics as:

- Petroleum supply
- High-octane aviation fuel
- Raw materials from the ocean for war products
- How magnesium is obtained and used today.
- Sulfa drugs
- Problems of vitamin supply
- Synthetic rubber
- New processes for making alcohol
- Plastics

This list, too, might be continued, and a similar list of topics in the field of physics might be drawn up. It would, of course, include many items about which much detail is withheld; for example, radar and the bazooka.

Developments to be expected during the coming year and during the period following the war make interesting topics for exploration. For example, recent reports on the gas turbine are most intriguing. Walkie-talkies aid the men on the fighting front, and have many possibilities for future use by the police and in numerous other ways. Future applications of electronics seem almost unlimited.

It is not possible for us to know at this time how many and what new devices the scientists are producing to help win the war. We are, however, led to believe that scientific research helped to conquer the submarine menace. The scientists of America have been mobilized for the study of war problems; to date, 650,000 medical men, engineers, and technicians have registered. The United States government is spending millions of dollars a year on research work for developing new devices for winning the war. Unless people have some idea of the scope of the research under way, and of the importance of its application, they are not likely to favor expenditures and appreciate contributions.

SELF AND SCIENCE

Harold H. Punke
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OBJECTIVITY is a keynote of science, and objectivity in handling data permits no interpretation to be influenced by the way in which it might affect the scientist personally. This is called eliminating the "personal factor" from research. The development of honesty and sincerity in this respect involves moral discipline.

Although such moral discipline is vital to science, one's orientation in relation to phenomena is also vital. To sense the scientific importance of phenomena one must view them in relation to one another, eliminating personal considerations entirely. Hence the scientist must outgrow the usual "self-oriented" conception of the world as the only significant pattern, and must operate in a wider "relationship-oriented" world. Relationship-orientation here means that phenomena are significant because of relationships among themselves. In most instances man is not the focal point around which such relationships are oriented. The concept of relationship-orientation is more abstract than the concept of man-centered orientation. Man-centeredness characterizes the outlook typical of primitive man—and of some present-day Americans who are considered educated. In view of the prevalence of man-centeredness in human history and of the importance to science that man-centeredness be outgrown, one should note how a conception of the self is developed, as well as how one gradually expands the self concept and—if the expansion is carried far enough—eventually develops the ability to appreciate relationships which are not self-oriented in the sense indicated.

There is considerable justification for saying that a very young child is highly self-centered: the things to which he gives attention are things that have a direct personal effect on him. The people of whom he is aware are those who bathe, caress, or do other things for him, and he is aware of them only when they are so occupied. That is, insofar as he is conscious of their existence, that existence is oriented on himself. The same can be said of blankets, cradle, and other inanimate objects. Obviously it is a long journey from this limited conception of the universe to the non-self-centered conception characterized as essential to the scientist, and it may be difficult to determine when the individual begins to move from the first stage toward the second. Suffice it to say that before the child begins to toddle he is aware that parents talk to each other, hand articles to each other, and respond to each other in other ways which seem without direct effect on the child. However, the fact that the young child is aware that people and objects move about in space does not mean that he conceives of any moving thing as having an existence similar to his own. He gets experience which helps him conceive of others as being similar to himself when he notes that they shrink and withdraw as he does in the presence of bangs and noises, that they, too, shiver when chilly, smile in response to smiling, and the like. Later he plays with other children, rolls balls back and forth, and romps generally in such ways as enable him to realize that he needs another person much like himself to participate in the play activity. Perhaps from this point onward language can be used by parents in helping the child put himself in another child's place—to show how his playmate might feel if not allowed to have the toys part of the time. The rate of growth in capacity to put oneself in the place of others varies among children, depending on scope of experience. After a little basic experience in satisfaction and denial, language and gesture can be used to

refer back to the basic experience as illustrative of what will result from doing certain things in the future.

It should be clear that parents and teachers can do much in providing a child with experiences which make it necessary for him to consider the influence that his actions might have on others, and thereby hasten the arrival of such maturity as enables him to realize that the other child has an existence similar to his own. The significance of curiosity and imagination in stimulating or thwarting growth along these lines is apparent. When geography and history are used to help the child expand his range of interest and understanding to include people and communities in remote parts of the world, he becomes less self-centered. The process can be fostered by astute guidance which shows the child that such cultural differences as language, religion, forms of government, or styles of architecture do not necessarily imply inferiority or superiority; that modes of living and of looking at life might vary from one's own without being inferior to it; that difference and inferiority are not synonymous. The study of the environment, with perhaps a gradual shift from the biological to the physical aspects of nature, should lead the child to understand relationships, meanings, and processes which do not directly involve people; and to note that some physical phenomena affect people directly, whereas others do not. He may thus, for example, become interested in the stars without thinking that they affect him or other people personally. If so, he is interested because of a relationship-orientation rather than a self-orientation. This relationship-orientation—an "intellectual curiosity"—is a more mature way of looking at the world than the self-orientation of his earlier life.

The immature person, regardless of age, sex, race or period of human history in which his life falls, is one who has not attained any appreciable degree of relationship-orientation, but lives in a narrow, self-oriented world. Self-orientation and relationship-orientation may be considered as being at the two ends of a scale on which each trait exists in varying degrees. The immature think of government, God, and the universe only in personal terms. Hence the personification of gods in religion, and the great variation in the degree of abstraction reflected by the beliefs of different religious groups. The extent to which the ancient Greeks were able to develop abstract thinking in such fields as geometry and philosophy, parallel with religious concepts which seem naïve today, suggests that relationship-orientation may advance much farther in some aspects of a culture than in other aspects. It would not be difficult to find illustrations of the same thing today.

It is not surprising that man, through moving outward in enlarging circles from primitive self-centeredness, developed an earth-centered conception of the universe before developing a sun-centered conception. With the earth as man's home, and with the sun, moon, and stars seeming to cross the horizon in an arc, it was easy to conclude that these heavenly bodies rotated around the earth. Indeed it is not casual observation of the unaided eye that now enables man to reject an earth-centered conception of the universe; it is largely a matter of observations by means of improved telescopes, together with mathematical tools not available in the classical world.

In view of the comments thus far on relationship-orientation in connection with science, perhaps one question should be raised: Is there after all any such thing as a selfless- or a relationship-orientation? It may be that phenomena necessarily become oriented in relation to one's own self. If one becomes interested in certain facts—about his grandmother or about the universe in general—it is because of relationships which those facts have to earlier facts or experience. Thus relationship seems to be the backbone of meaning. From simple experiences of early life one acquires a basis for more intricate meanings—and

the process continues until death or intellectual stagnation. But these simple, early experiences, going back to cradle days, are meaningful because they have some direct effect on the individual.

Hence there seems to be a thread of continuity from the simple personal experiences of early life to the most complex system of relationships that the individual can understand, with the difference being largely in the immediacy of the personal interest. Certainly if one did not get some kind of satisfaction from formulating theories about such things as atoms, earthworms, and dictators, one would not voluntarily spend much time and energy in working out the formulations. Two possible avenues of personal satisfaction or self-interest seem open to the scientist, from work often characterized as free from self-orientation or which has had "the personal factor abstracted": (1) the probability of approval of his results—or at least of his efforts—by the public or by a circle of friends; and (2) the individual satisfaction experienced when he overcomes obstacles and masters difficulties.

There may be no such thing as selflessness of orientation in regard to anything with which an individual comes in contact. If a phenomenon has acquired any degree of orientation whatever, so far as a given person is concerned, it is an orientation which focuses on that person. Perhaps there is difference among the phenomena to which one gives attention in their nearness to the center of his organization of personality or scheme of values, but none of these phenomena could be considered to lie wholly outside that organization or scheme. It thus appears that there are degrees of centrality or selfness, rather than a dichotomy of centrality versus externality.

The implication that scientific orientation is a projection of the kind of orientation the child shows regarding his experiences in no way detracts from the importance of science or of scientists. The capacity of a scientist to appraise data objectively and to consider different approaches to a problem retains its importance. There might, however, be some change in viewpoint concerning the development of scientific-mindedness. If scientific-mindedness is merely a greater degree of the objectivity which we all develop to some extent as we move from infancy toward maturity, it should be easier through an educational program or otherwise to guide the child's mind so that it will develop in the direction of scientific-mindedness, than if scientific-mindedness is conceived as something wholly different and apart from the experiences and growth of ordinary folk.

TEACHING SUGGESTIONS AND REPORTS

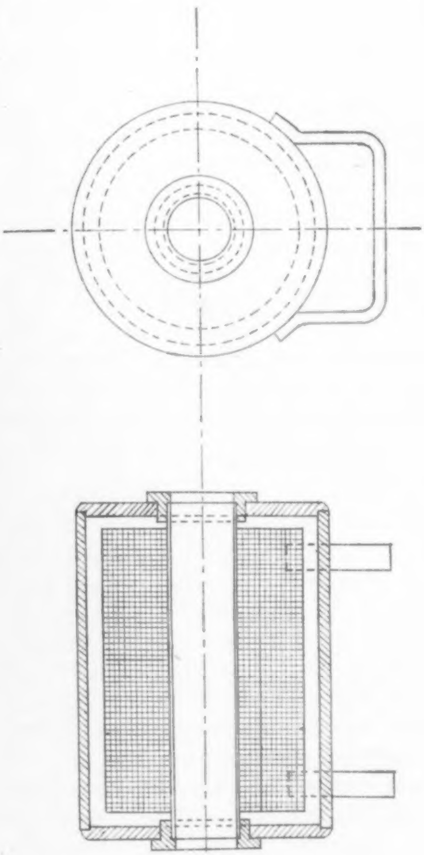
A MAGNETIZER

Equipment for remagnetizing permanent magnets that have lost their original strength is indispensable in the school laboratory. With the usual rough handling by students, permanent magnets lose most of their magnetism in a year or two and need rejuvenating if they are to perform properly. No originality is claimed for this piece of equipment; it is reported here only because it can be assembled from noncritical materials.

The coil and its housing were obtained from an obsolete electro-dynamic radio speaker. The field coil has a resistance of about 6 ohms and was intended to be energized from a 6-volt storage battery. Such coils are wound with large wire that will easily stand 5 amperes for 5 or 10 minutes. It is important that the coil have a center hole large enough for the magnet to pass through. No dimensions are given in the drawing since they will be determined by the speaker coil available. A radio chassis

8 x 10 x 2 inches provides a convenient base.

A tube of nonmagnetic material, just the right size to slip into the hole in the coil, was made from a sheet of copper formed around a pipe. After the tube was formed, the lap was soldered. To hold the tube, two brass rings were turned to the shape



shown. The coil was assembled and the two rings sweated into the center tube. This also served to hold the end plates in place.

The most desirable source of power is 110-volt D.C. To limit the current to a safe value of 5 amperes, a limiting series resistance is needed. This was made of a 550-watt 110-volt screw-in heating coil. Part of the wire was removed, a bit at a time, until the current reached 5 amperes as shown by an ammeter. To provide safety, a socket bearing a 6-ampere fuse was included in the circuit.

In use, bar magnets are pushed directly through the coil. Polarity is determined by the direction in which they are pushed through it. U-shaped magnets are magnetized by putting one leg into one end of the coil, withdrawing it, and then inserting the other leg of the magnet into the other end of the coil.

It is possible to use the apparatus on alternating current, but not very satisfactorily. If A.C. must be used, the limiting resistance may be less because the impedance of the coil will be quite high. The magnet is inserted and then the current is suddenly shut off. If this is done at the proper instant, the magnet will be remagnetized, and in the proper polarity. However, several attempts may be necessary for the desired condition to be reached.

RAYMOND AGREN
Southfield Vocational High School
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THE DANCING DOLLS

A fascinating toy for the home or for placing before a class just being introduced to static electricity is easily made and will interest students of every age. I presume that there are many plastics that may be used, but I shall describe one that I made, which gives excellent results.

Secure a sheet of Pliofilm 0.01 inch thick and 8 inches in diameter, and a Pliofilm strip about 26 x 2 inches. Leaving eight equally spaced flaps about ½ inch wide and ½ inch deep, cut a disk about 7 inches in diameter from the Pliofilm. The disk is to be the top of an enclosure supported by a wall of Pliofilm. The wall should be 1¾ to 2 inches deep. Cut this long enough

(about 24 inches to 26 inches) so that the ends of the strip will overlap to form a wall. Bend the flaps at right angles to the edge of the disk and fasten them to the wall with a stapler.

Cut paper dolls from *very thin* tissue paper. They should be 1/3 to 1/2 inch shorter than the height of the wall. To help keep the dolls in an upright position, fasten a small piece of wax near their feet. Fold the dolls slightly on a vertical axis, and bend the arms to positions that will give a twisting action as they rise. Two dolls may have hands joined, but single ones usually perform better.

Place the dolls on a metal plate; cover with the Pliofilm enclosure. Rub the Pliofilm disk with dry fingers to give it an electric charge. Under favorable atmospheric conditions, action of the dolls will continue for a long time. The action may be varied by holding positively and negatively charged rods alternately above the Pliofilm disk. The device may be used without the metal base, but the metal adds to the speed of reaction.

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A USEFUL MODIFICATION OF THE TEST TUBE

Those science teachers who believe in increasing the number of experiences students can meet in the science laboratory are constantly searching for equipment that is simple in construction and inexpensive enough to warrant its distribution to all students. Such a piece of equipment is the modified (or indented) test tube (Fig. 1) which has been tested by use in the laboratories of Forest Hills High School and by teachers taking the course in Laboratory Techniques at Teachers College, Columbia University.

This V-tube (for want of a suitable name) is simple to prepare, yet it lends itself to a variety of purposes. An ordinary soft glass test tube is heated in the flame of a Bunsen burner at the point where the indentation is desired. When an orange flame is produced, or when the glass is considered soft enough, this heated portion is pressed quickly against a glass rod and the softened glass is indented. The depth of the indentation may be regulated by the pressure applied and by the dimensions of the glass rod. This tube may then be used in many ways, several of which are described here.

For culturing bacteria or molds.—It is sometimes impossible or too expensive to obtain sufficient Petri dishes for every student. A V-tube may be used as a substitute. The culture medium is poured into the tube, which is plugged and placed on its side as in Fig. 1. A large surface is thus obtained for inoculation; the indentation dams up the culture medium, fluid or solid, and thus permits a flat surface. Bacterial counts, inoculations of different kinds, growths of Rhizopus, Penicillium or other molds, or any cultures which require a surface larger than that of the slant, are made possible. Uses of a similar nature will occur to other teachers.

FIG. 1

As a generator of gases.—In this case the indentation is made in the center of the tube (Fig. 2); it should be deeper than that shown in Fig. 1. The lower compartment is filled with weak acid; the upper compartment with iron sulphide if hydrogen sulphide is desired, with calcium carbonate if carbon dioxide is desired, with lump zinc if hydrogen is desired. A rubber stopper with a delivery tube is inserted in the mouth of the tube.

When the tube is inverted, the acid flows over the solid and gas is generated. Care must be taken to limit the amount of acid

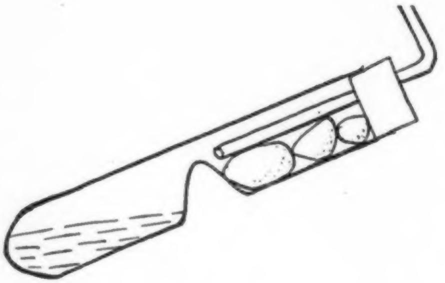

Fig. 2

and its flow so that it does not enter the delivery tube when the test tube is inverted. When it is desired to stop the generation of gas, the tube is placed bottom side down in a rack. The indentation prevents the solid from falling into the acid and the reaction stops. Each student thus has his own generator, one which is economical of chemicals and of space.

This tube can be used for any technique which requires the separation, in a closed tube, of two substances that are subsequently mixed to produce a reaction.

Paul F. Brandwein
Forest Hills High School
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A, AB, B, OR O?

Public interest in blood groups has been aroused by the establishment of blood banks in almost every community. Although youth under eighteen years of age are not eligible to donate blood to the banks, they have a real interest in the process, in the use made of the blood, and in blood groups in relation to race and heredity. In our biology classes, these facts became apparent soon after we began work on the nature and function of blood in the human body. Because of this interest, it was decided to "type" all students who wished to participate in such an activity. The objective of the typing was not to determine exactly what blood group an individual belonged to, but to make more meaningful the concept of blood groups and the process whereby an individual's blood type is determined.

Blood typing is not particularly difficult. It requires no special equipment or supplies other than serum, which can be obtained from a hospital laboratory, with the aid of a physician if necessary. The activity is one which science teachers can carry on with the expectation of meaningful results. It should be pointed out that the results will not be reliable in every case, but this fact need not worry anyone as long as the students understand it.

PRELIMINARY PREPARATIONS

Three or four days in advance of the typing, A and B sera were ordered from a hospital laboratory, 1 ml. of each serum for about 50 students. A slide was prepared for each student in as sterile a manner as possible. Each slide was divided into two parts marked "A" and "B" with a marking pencil. Four 5-ml. pipettes and several substitutes made by drawing out glass tubing were sterilized. Physiological solution (0.85 per cent NaCl) was prepared. A fresh box of toothpicks was on hand (to be used for mixing serum and blood).

During a preliminary discussion of the procedure the various steps were enumerated and the role of the serum explained. The typing technique was demonstrated, using the blood of one of the students.

PROCEDURE

Each student was then given an opportunity to have his blood typed. The procedure was to some extent that of an assembly line. One student checked each slide to make sure that it was clean and properly marked. He passed it to a second student who placed a drop of each serum on the appropriate side of the slide. The slide was then handed to the student who was being typed. The school nurse punctured this student's finger and the class teacher drew up about 0.5 ml. of blood into a pipette which already contained about 1 ml. of saline solution. Then the

teacher placed a drop of the blood-saline mixture on each of the drops of serum on the student's slide. The student then mixed the diluted blood and the serum with a clean toothpick and observed both drops closely for signs of clumping. The low-power objective of the microscope was used, although the clumping could be seen with the naked eye.

It should be noted here that it is unnecessary to use saline solution, a drop of blood can be placed directly on the slide and mixed with the serum. The results, however, are somewhat less accurate.

INTERPRETATION

The students noted four kinds of reactions. Some found that the blood mixed with A serum clumped; some found that the blood mixed with B serum clumped; others found that both clumped, and still others that neither clumped. To interpret the results in terms of blood groups, it was necessary to point out that blood either does or does not contain substances called agglutinins and agglutinogens, the former in serum and the latter in corpuscles. For clumping to take place, both agglutinin and agglutinogen must be present. Agglutinin *b* is contained in A serum, agglutinin *a* in B serum. Blood which clumps or agglutinates when added to serum A but not when added to serum B belongs to the B group. Blood agglutinated by serum B but not by serum A belongs to the A group. Blood agglutinated by both sera is in the AB group, that agglutinated by neither is in the O group. A method for clarifying the relationships between the agglutinins and the agglutinogens is indicated by the following table:

Blood type	Agglutinins (serum)	Agglutinogens (corpuscles)
A	*b*	A
B	*a*	B
AB	none	A and B
O	*a* and *b*	none

SOME IMPLICATIONS

In the discussion following the typing, the students wanted to know whether or not one type of blood was "better" than another; whether a person with type A blood, for example, had any advantage over a person who had type O blood. They raised the problem of how we acquire our blood type, and it was necessary to review a few facts of heredity. The inheritance of blood types follows Mendel's law. Types A and B are dominant and type O is recessive. There are six genotypes. Possible results from a variety of matings were tabulated. In this connection, the question of establishing paternity was raised. A table was constructed to show how the exclusion principle could be applied and to show also that in many cases it is impossible to identify paternity from blood tests alone.

Questions were asked concerning racial differences in blood types, and the students' results were applied to this problem. Three "races" were represented among the students. No racial differences in the distribution of blood types were found. The tentative conclusion of the class members that blood type was no indication of race was strengthened by study of a table showing racial distribution of blood types on a world basis.

Finally, the students asked about blood transfusions and from discussion of this question moved to consideration of the policy of American blood banks in separating the blood of our two major races. A significant conclusion, voiced by the students, was that here was a great opportunity—as yet unaccepted—to help people straighten out some of their racial misconceptions. And all the help we can get in this area is sadly needed today.

HUBERT M. EVANS AND
HAROLD TANNENBAUM
Horace Mann-Lincoln School
Teachers College, Columbia University

MEETINGS OF SIGNIFICANCE

THE INTERNATIONAL EDUCATION ASSEMBLY

In the United States more than thirty educational organizations have recently joined to form the Liaison Committee for International Education in order to coordinate their study of the educational needs of the post-war world and to implement this study with appropriate action. In the fall of 1943 a group of educators representing a cross-section of American educational leaders and qualified educators from twenty-six of the United Nations and neutral nations met at Harpers Ferry and joined with the Liaison Committee to form the International Education Assembly. Newly formed as an outgrowth of these deliberations is the "American Association for an International Office of Education." It is of interest to science teachers aware of the potential significance of their work in social education that this latter association has as its chairman a renowned scientist: Harlow Shapley, director of the Harvard College Observatory.

The need for cooperative study and attack on the urgent problems of educating American people and the peoples of the world for international understanding and constructive cooperation is obvious. The means and techniques are less so. But the clear fact that it has been the sharp sword of science which has narrowed the world to make either world cooperation and understanding or world catastrophe inevitable implies heavy educational responsibilities for science teachers who represent the advance and impact of science to American young people. Surely the science-trained teacher finds personal responsibility in the following quotation from the report of the Harpers Ferry Meeting:

"... the very rapid expansion of knowledge, the great extension of communication and transportation through the radio and the airplane, the more intimate contacts and interchanges between cultural groups, the greater economic and cultural interdependence, and the need and the likelihood of extensive cooperation among nations in the post-war period all point to the need of appropriate education to give the people an understanding of this emerging world and to support wise cooperative action among nations." [1]

R. Will Burnett
School of Education, Stanford University

THE PLANNING CONFERENCE OF SCIENCE TEACHERS IN NEGRO COLLEGES

A meeting of science teachers in Negro colleges was held in Chicago from October 26 to 28, 1943, in conjunction with the Twenty-first Annual Session of the Presidents of Negro Land-Grant Colleges. This conference was in part an outgrowth of some studies which were begun last April in the Bureau of Educational Research in Science at Teachers College, Columbia University. These studies were made possible through fellowship grants from the General Education Board, secured by the Association of Colleges and Secondary Schools for Negroes. In the beginning, three science teachers from as many Negro colleges were sent to the Bureau to study problems and resources of the southern regions. This group, with a fourth member added later, continued its studies in connection with the Bureau's 1943 Summer Workshop for science teachers.

The studies of the Negro college group centered about problems of southern Negroes from the standpoints of science approaches for improving the socio-economic and cultural relations of that area. The main topics of the study included analyses of the physical, biological, human, and economic resources of the area as they related to agriculture, industry, health,

[1] International Education Assembly. *Education for International Security,* p. 5, Sept., 1943.

housing, recreation, education, and intergroup adjustments. Toward the end of the Workshop period, plans were made for continuing the study and for broadening its influence in the southern regions. The latter consideration led to the decision that a meeting of science teachers in Negro colleges should be arranged.

The Land-Grant Conference was very cooperative in making the meeting possible. Ten science teachers representing eight colleges were in attendance. In one way or another, nearly all of the presidents of the twenty-four member and associate institutions participated in the science conferences. The discussions during the first two days were concerned chiefly with (a) functions of science education in Negro colleges, (b) academic approaches to preparation for scientific living, (c) responsibilities of Negro science teachers in achieving a truly democratic America, and (d) procedures for realizing the programs planned by the science teachers. On the third and final day of the meeting, two science teachers and a Negro industrial chemist addressed a joint session of the Conference on subjects relating to science education and vocational outlooks for Negroes in science.

It was a general feeling of the group that the following conditions posed the major science-relations problems in the Negro college and community:

(1) Developing and maintaining the proper relationships between college science teaching and the problems of living.
(2) Improvements of facilities for science teaching and professional growth.
(3) Effective utilization of the natural, economic, and human resources in the science education program.

All members of the group, without exception, felt that these problems might be attacked best by the science teachers if a medium existed through which their efforts could be coordinated. This opinion gave impetus to the organization of the "National Association of Science Teachers in Negro Colleges." Dr. Thomas W. Turner, Head of Unit of Natural Sciences, Hampton Institute, Hampton, Virginia, was elected to the presidency of the Association. The organization was designed to be mainly a cooperating body to work with colleges, high schools, and other agencies on problems such as those considered by the Southern Regional Study in Science.

A report on the proceedings of the Chicago meeting was sent out to the five Regional Directors of the Association and to members of certain other interested groups. Some have already reproduced and distributed the report to the colleges in their respective regions. Steps have been taken in the several regions to study the major problems and methods of attack. Certain agencies have been presented with requests for grants to develop specific programs in science. Intercollege science staff meetings have been held in some of the regions. Others have been planned for the spring and summer. The Association will hold its first annual meeting on May 14 and 15 at Fort Valley State College, Fort Valley, Georgia.

At the same time the science teachers were meeting in Chicago, plans were completed for the establishment of the Fort Valley Research Station in the Biological Sciences. This project was made possible by a grant from the General Education Board. It will be operated jointly by Fort Valley State College and several cooperating colleges. This Station will provide an opportunity for science teachers to improve themselves professionally, and for the new association to conduct certain aspects of the programs it hopes to sponsor.

The science teachers wish to acknowledge gratefully the invaluable assistance given in various ways by the General Education Board, the Association of College and Secondary Schools for Negroes, the Secondary School Study for Negroes, the

Teachers College Bureau of Educational Research in Science, the Conference of Presidents of Negro Land-Grant Colleges, and the presidents of the many colleges who have pledged their support to the programs which the science teachers planned.

H. B. Crouch
Kentucky State College, Frankfort

N.A.R.S.T.

During the present calendar year the National Association for Research in Science Teaching has held four regional meetings: in Detroit on January 19, in Chicago on February 29, in New York on March 18, and in Cleveland on April 5. Discussion at the Detroit meeting centered on three topics:

Some proposals for a National Commission on Science Teaching.
Science teaching in post-war planning.
Science teaching in a program of aviation instruction.

At the Chicago meeting discussion was devoted especially to the question of whether Science Education should be developed to include more practical material of interest to classroom teachers or whether it should remain primarily a research journal. A proposal for a National Commission on Science Teaching was read and discussed. There was also a brief consideration of the policies of N.A.R.S.T.

The New York meeting was held jointly with the National Council on Elementary Science. There were morning and afternoon sessions open not only to members of the cooperating organizations but also to all those interested in science education. A dinner and evening meeting was held for members of N.A.R.S.T.

Dr. M. L. Robertson of New York University presided at the morning session. Four papers were presented: "Recent Important Research Studies in the Teaching of Science," by H. Emmett Brown, Horace Mann-Lincoln School, Teachers College, Columbia University; "Science in the Elementary School and the Air Age," by Florence G. Billig, Wayne University, Detroit; "Contributions of Science in Secondary Schools to the War Effort," by Morris Meister, The Bronx High School of Science, New York; and "Wings of the Future," by C. C. Furnas, Director of Research, Airplane Division, Curtiss-Wright Corporation, Buffalo, New York.

The topic for the afternoon session was "Science Teaching in Post-War Planning." The discussion was under the leadership of Samuel Ralph Powers, of Teachers College, Columbia University. It was opened by a panel, whose members were: Paul F. Brandwein, Forest Hills High School, New York; A. E. Dick, William Taft High School, New York; Hubert M. Evans, Horace Mann-Lincoln School, Teachers College, Columbia University; J. G. Manzer, Central High School, Trenton, New Jersey; and W. A. Kilgore, Wilson Teachers College, Washington, D. C. There was vigorous discussion from the floor.

At the evening meeting there was general discussion of the policies of N.A.R.S.T. and of the proposal for a National Commission on Science Teaching.

Abstracts of the talks by Dr. Brown, Dr. Meister, and Dr. Furnas are given below. Dr. Billig's paper is published in full elsewhere in this issue.

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The studies listed fall into four categories: those concerned with the development of war courses; those relating to methods and procedures of teaching and learning; those analyzing the opinions of teachers; and those pertaining more generally to the science curriculum. Certain of these studies were originally published in SCIENCE EDUCATION (Curtis, Hunter, Joseph, Novak, Wise); others were abstracted or reported in part in this journal (Brewer, Urban). It is obviously unnecessary to review these reports here.

The major portion of the time available for discussion was devoted to consideration of investigations of teaching and learning, three of which are summarized below.

Elementary School Science

Miss Bergen examined the choice of a source of information which children make when confronted with problem situations

in science. She kept running records of regular classroom sessions, and conducted individual interviews in which children were asked a set of previously selected questions. She found that children used or suggested both empirical and authoritarian sources of information in the classroom, neither type predominating. In the interviews, the same children suggested empirical sources more often. There was some evidence of the influence of the frequency of the classroom teacher's statements of scientific attitudes on the frequency of those of the children in her class. Children emphasized the same source of information in the interviews that the teacher had previously emphasized during class sessions.

All the sources of information suggested in the classroom were mentioned by both boys and girls. Boys suggested more sources than girls did, but boys also spoke more often in class. More than half the experiments suggested in the classroom were actually suggested by girls; boys seemed more inclined to refer to authorities. No sex differences were found in the interviews. In general, the children seemed to exercise common sense in selecting sources of information.

Opinions and Information

The study reported in *Youth Considers the Heavens* was undertaken in an effort to identify changes in young people's philosophical conceptions of man's relation to the universe as their information about the nature of the universe increases. On a check list which was carefully prepared and validated, high school physics students expressed their opinions about man's place in the universe; then some of them studied specified astronomical material and some returned to their usual physics lessons. Later, all the students responded to a comparable opinion check list. Each person's two expressions of opinion were compared and were also studied with reference to scores on an intelligence test and on pretests and post-tests of information about the extent of the universe. It was found that the more intelligent individuals and those having the greater fund of information about the extent of the universe were more likely to reject an opinion that man is dominated by supernatural powers.

The subject matter studied was specified in two ways. Certain teachers were given a list of generalizations concerning the vastness of the universe and were encouraged to teach in whatever manner they deemed most effective for developing a comprehension of these generalizations. In other classes the students were supplied with copies of a pamphlet written to develop the same generalizations, and the teachers of these students were requested to refrain from discussing the subject matter or its implications in class. The boys and girls who studied the pamphlet showed a greater change both in information and in opinion than those in the former group.

The results are interpreted on the assumption that an emotionally satisfying philosophy of living can grow and mature only in relation to a world picture which is in accord with the best knowledge available. It would appear, therefore, that astronomical subject matter should be given place in the senior high school science curriculum (from which it is ordinarily omitted) in order that young people may have opportunity to develop a world picture consistent with modern knowledge. This recommendation is supported by statements of high school students themselves, who testify to their concern with the general problem of man's relation to the universe and to their serious consideration of questions of a philosophical nature.

An Experimental Science Course

Mr. Everote analyzed two outcomes of instruction in an experimental-type science course: grade-point improvement in high school courses taken coincident with and following enrollment in experimental-science, and development of understandings and perspectives of students regarding the

roles of science, scientists, laymen, and students in large-scale planning. The experimental course emphasized the services rendered by natural science to selected experiences within students' social, industrial, and recreational environment.

The grades of 460 students were analyzed. The students were matched on the basis of intelligence quotients; of each pair, one had enrolled in the experimental-science course and the other in a chemistry course. Comparison of grade points earned during and after taking the science courses with those earned before that experience showed significantly higher averages for the experimental-science students than for members of the control group.

A unit pertaining to agriculture was selected for intensive study. One aspect of this part of the investigation concerned changes in students' opinions regarding some seventy agricultural problems; for example: should post-war agricultural planning be undertaken on a national scale to improve the American farm standard of living? It was found that changes in student thinking on these issues distinctly favored basic tenets of large-scale planning for national agricultural production and showed development of perspectives regarding the interrelations of rural and urban peoples brought about by technological advances.

SECONDARY SCIENCE AND THE WAR EFFORT

In Dr. Meister's talk, war-time curricular developments in secondary school science were noted chronologically. Just after Pearl Harbor, there was a concentration of effort on the techniques of civilian defense; such matters as extinguishing bombs and fighting fires were emphasized. Shortly thereafter came the emphasis on education for the coming air age, and a series of instructional materials on pre-flight aeronautics was prepared by an unprecedented cooperative group effort. At the same time a general call for "more physics" and "more mathematics" was heard; it was not until later that the questions of what physics and what mathematics were clearly raised.

During the school year 1942–1943 there were two chief trends. One was toward Pre-Induction Training centered on simple skills. Publishing houses cooperated with the government and with each other to bring out textbooks on fundamentals of machines, of electricity, of radio, and so forth. The second trend derived from the realization that high school students need guidance with respect to their health, and from the recognition of the importance of understanding in problems of habit-formation.

One development, not entirely to the good, was the stress on intensive vocational training for all age levels. This emphasis in secondary schools resulted in the neglect of such training for older men and women and thus may well have contributed to the present man-power shortage.

A final effect of the war effort on the high school curriculum comes from the Army Specialized Training Program.

Teaching procedures, as well as curricula, have been affected by the war. For one thing, science teachers must learn to use noncritical materials in their teaching. As a result, they have been developing their ingenuity, improving their demonstrations, and turning away from cook-book methods in the laboratory. They have likewise learned to look to visual aids as a source of instructional materials. Furthermore, teachers have found themselves participating more and more in community life: helping with salvage campaigns, for example, or conducting soil-testing stations for victory gardeners. Finally, they have had forcibly brought to their attention the need for concern with democratic and intercultural education, and the importance of science as a way of finding truth.

WINGS FOR THE FUTURE

Dr. Furnas discussed the development of commercial aviation in the next ten years

by consideration of three questions: How fast? How large? How many?

How Fast?

There are two limiting factors to the speed of airplanes. One is physical. The relation of the drag coefficient to the velocity is fairly constant until the velocity approaches the sonic region; then it increases enormously. At present the upper limit of the speed of airplanes seems to be about 750 miles per hour. The other factor is economic: it costs money to go fast.

Aviation should enable Americans to get from one point in the country to another in the space of a working day or of a night's sleep. Coast-to-coast transport in five or six hours is desirable. This means that transport planes should have a cruising speed of 500–600 miles per hour. At present this is the speed of military planes; transports average about 180 miles per hour. It is probable that within the next ten years the cruising speeds of transport planes will be between 300 and 600 miles per hour.

How Large?

There is no particular physical limit to the size of airplanes, but there is an economic limit. If transport planes are to be of use to the public, frequency of service is necessary. Air lines will not be able to afford to run empty planes. The maximum capacity of the airplanes used on the transcontinental lines will probably be fifty passengers, but may be as much as one hundred passengers. Transoceanic runs will be less frequent than transcontinental trips, and will probably be made by 100-passenger planes. Feeder lines, to supply "local" service, will carry only fifteen to twenty passengers.

How Many?

In 1941, 350 commercial airplanes carried all the passenger air traffic in the United States. At present, more passengers are being carried by fewer than 200 airplanes, and these airplanes are comparatively slow and small. Travel by air may be expected to increase after the war, in part because air transport service will be more reliable, but even so only a few hundred commercial airplanes will be needed. We are now producing 100,000 large planes per year. Airplanes built within the last twelve years do not wear out. Their average economic life is five years, but many now in operation have been used for fifteen years. It appears that at most only a few thousand airplanes will be needed in the next decade.

Private airplanes are, of course, a different matter, but the private airplane market must not be thought of in the same terms as the private automobile market. "Flivvers of the air" will cost a Cadillac's price, not a Ford's. Private helicopters and airplanes will be owned by three-car families, cattle ranchers, and large farmers. There will be a demand for a few hundred thousand such vehicles, not for millions of them.

GERALD S. CRAIG
Teachers College, Columbia University

N.C.E.S.

The National Council on Elementary Science met with the National Association for Research in Science Teaching at the regional meeting in New York on March 18. At this time a business meeting of the organization was held. The President, Martin L. Robertson, appointed Lois Meier Shoemaker as acting Secretary-Treasurer. Victor L. Crowell was appointed member of the Board of Directors.

The President was authorized to plan for a regional meeting in New York in the autumn of 1944. Dorothy E. Wheatley and George W. Haupt were appointed as a committee to arrange a program for this meeting.

Dues of $1.00 annually are now payable for the year 1944 and may be sent to the acting Secretary-Treasurer.

LOIS MEIER SHOEMAKER
State Teachers College, Trenton, New Jersey

SCIENCE EDUCATION: WHAT SHALL IT BE?

DURING the past few months, many persons have been asked for suggestions as to ways in which SCIENCE EDUCATION may best serve its readers. The following brief statements have been culled from letters received in response to such requests:

I hope . . . that the matter of research can continue to be emphasized. Associated with research articles, there should be other articles germanely connected with the materials and problems of classroom procedures.

F. C. JEAN
Colorado State College of Education
Greeley, Colorado

Science education is bound to expand enormously in the years ahead, and one of the serious limiting factors will be the inadequacy of a body of teachers who will be given the task. . . . I believe that for a long time to come the most conscious demand on the part of science teachers who want to improve their competence will be for concrete advice on *how* to teach one or another particular "topic"; devices for demonstrations; tricks for keeping charts in shape or for arranging apparatus and taking care of laboratory plants and animals. . . . I should, however, be interested in a discussion of some other problems of science teaching that seem to me worth serious consideration on the part of science teachers—problems of "what" to teach rather than "how" to teach, although these two are not, of course, entirely separable. I have in mind the many questions that trouble younger teachers: handling "controversial issues"; "teaching scientific methods"; the social implications of some of the scientific doctrines, etc., etc.

BENJAMIN C. GRUENBERG
418 Central Park West
New York, New York

I believe that its primary contribution should continue to be the report of significant research work in the field of science education. I don't believe that it should be converted into a popular journal appealing mainly to the entertainment of science teachers. In my opinion it should appeal to those science teachers who believe that the way of making genuine additions to our knowledge of science education is through the application of the methods of science to the problems of science education. In this respect, SCIENCE EDUCATION has occupied a unique position among science journals in the past and I strongly recommend that this uniqueness be maintained. It should be constantly attentive to bringing to the readers improved methods of designing investigations and of analyzing data. . . .

PALMER O. JOHNSON
College of Education
University of Minnesota
Minneapolis, Minnesota

Personally, a publication devoted to reviews of new scientific developments, of good literature, and ways of teaching units in science, giving specific details, would be far more valuable to me than one with articles of more theoretical slant.

R. A. WALDRON
State Teachers College
Slippery Rock, Pennsylvania

The magazine was founded as a medium for the publication of articles on research in problems of science teaching. I hope it can continue so to function. I hope the articles it publishes along this line can be kept at a high level.

ELLIOT R. DOWNING
Williams Bay, Wisconsin

There might be certain contributions which could be made with reference to health education. In spite of considerable work done in the field of health education, I have always felt that it is very incompletely done. If we wish to have a healthier nation, much more pointed and efficient health education must be carried on from the elementary schools to the higher levels. I don't think physical education, as a department now constituted, takes care of the matter adequately, and science education has never been given the job.

A. W. HURD
Medical College of Virginia
Richmond, Virginia

I believe that it would be well to decide upon the various areas which are to be treated in the Journal, and then select some person to be responsible for reviewing as well as preparing materials for this section. Perhaps the entire membership of N.A.R.S.T. could be canvassed in order to discover special interests; this would help the responsible person in approaching people for articles. As an example, I would suggest that someone be made responsible for materials relating to the evaluation of science programs, curriculum construction, sensory aids, the science laboratory, promising methods and materials, and the like.

PHILIP G. JOHNSON
New York State College of Agriculture
Cornell University
Ithaca, New York

THE TENTATIVE PLAN OF THE COMMITTEE ON PUBLICATION

To the Committee on Publication it seems that SCIENCE EDUCATION has a dual purpose. One aim of the journal is to serve teachers of science at all levels; above the Table of Contents appear the words: "serving teachers in elementary schools, junior and senior high schools, colleges, and professional schools for teachers." The

other aim, by no means unrelated to the first, is to report and interpret research in science teaching. The Committee has attempted to think through the problem of what the contents of SCIENCE EDUCATION should be in order that these aims may be achieved.

It appears probable that science teachers at all levels find it worth their while to read articles concerned with recent developments in scientific research which affect people's lives and hence should affect teaching, and articles concerned with developments in industry, agriculture, and government which may affect the teaching of science. Second, all science teachers may be served by articles concerned with the patterns and traditions which affect their work, and with reports of significant tendencies in science teaching. Third, science teachers on the secondary and college levels especially might find value in papers concerned with the coordination of the efforts of teachers of different subjects toward the accomplishment of the aims of general education, and teachers at the elementary and secondary levels especially might be served by reports of specific procedures which they could adapt for use in their classes. Fourth, many teachers of science have need for carefully prepared reviews of available reading and teaching materials.

Finally, as a research journal, SCIENCE EDUCATION should serve as a clearing house for research in science teaching. To this end, its pages should be open to somewhat detailed reports of such research. It should publish digests of research studies; criticisms, interpretations, and discussions of their significance; and papers dealing with methods and techniques appropriate for use in educational research.

Considerations such as these lead the Committee on Publication to suggest the following tentative plan for the journal. Each of the divisions in the plan represents a proposed department of the journal.

Science Today

This department would contain one or two major articles on the implications for science teachers of recent developments in scientific research. The first three issues of Volume 28 include four articles of this type.

Science in the Community

This department would contain one or two major articles on community, state, and national projects; for example, on governmental programs in health and nutrition, on plans for pre- and post-induction training, on new techniques for the production and distribution of consumer goods.

Research in Science Teaching

Through this department, SCIENCE EDUCATION would maintain and further its unique function as a journal of research in science teaching.

Significant Trends in Education in Relation to Science Teaching

Here would be reported and interpreted the recommendations of policy-making bodies such as the Educational Policies Commission, the High School Principals Association, the North Central Association of Colleges and Secondary Schools, the Southern Association of Colleges and Secondary Schools, the College Entrance Examination Board, and the New York State Board of Regents.

Teaching Reports and Suggestions

This department would include reports of teaching in science classes at various levels—articles which make readers feel that they have visited the authors' classrooms; suggestions for field trips, including specific plans for trips to study such subjects as housing, plant succession, and agricultural projects; evaluation materials which could be reproduced for use in classes, especially instruments designed to test reasoning, critical thinking, and attitudes; directions for unusual experiments

and for making handy gadgets; and suggestions for the use of visual and auditory aids.

The Science Teacher's Heritage

Under this heading would appear articles on the history of science and of science teaching, biographies of great scientists and science teachers, and the like.

Reviews and Abstracts

In addition to containing abstracts of current periodical literature and reviews of books especially useful for teachers, this department would include reviews of visual aid materials and of textbooks.

A CALL FOR ADVICE

It is hoped that this plan, or a revision of it, may be instituted in the issue of October, 1944. Before plans for that number are completed, the Committee on Publication would like to learn the wishes of the readers of SCIENCE EDUCATION. To facilitate the expression of opinion, a brief questionnaire is given below. Readers may render a real service by detaching the questionnaire, filling it in, and mailing to the Committee at Box 58, Teachers College, Columbia University, New York 27. Readers who prefer to keep their copies of journals intact may render the same service by incorporating their answers to the questions in letters to the Committee.

1. Do you believe that the departments as proposed by the Committee in the foregoing pages have sufficient value to be included in the journal? (Please write Yes or No in front of the name of each department; comment if you will.)

.... Science Today
.... Science in the Community
.... Research in Science Teaching
.... Significant Trends in Education
.... Teaching Reports and Suggestions
.... The Science Teacher's Heritage
.... Reviews and Abstracts

2. Are there any other departments or kinds of reports which you believe should be incorporated in SCIENCE EDUCATION? If so, what?

....

....

....

3. What kinds of Book Reviews should the journal publish?

.... Critical and somewhat detailed
.... Brief, indicating mainly the scope of the book under consideration

4. What kinds of books should be reviewed?

.... College textbooks
.... Textbooks for elementary and secondary schools
.... Books interpreting science materials for teachers and educated laymen
.... Books on education

5. Please indicate which journals you would like most to see abstracted.

....

....

....

6. The present publication schedule of SCIENCE EDUCATION is as follows: February, March, April, October, and December. What is your opinion, as a reader, of this schedule?

.... It is satisfactory.
.... SCIENCE EDUCATION should become a quarterly.
.... The publication does not appear often enough.
.... Five times a year is sufficiently frequent, but issues should be differently spaced. (Please indicate the spacing you would prefer.)

....

....

SUMMER SESSION ANNOUNCEMENTS

UNIVERSITY OF CHICAGO

Special features of the University of Chicago Workshop this summer will be sections on Inter-American Education and Aviation Education. Participants, in addition to receiving help and counsel from consultants especially selected for their competence in these fields, will hear lectures, see films and have access to much new material on Latin-America and Aviation.

Ralph W. Tyler, Chairman of the Department of Education, is director of the Workshop, which will include sections on Elementary and Secondary Education, and Human Development. Teachers, administrators and librarians who wish help in solving problems in their own classrooms and in adjusting their schools to war and post-war demands will be particularly interested in the offerings in curriculum, guidance, and evaluation.

A limited number of scholarships paying either full or half tuition are available. Further information may be secured by writing to James B. Enochs, Executive Secretary of the Workshop, University of Chicago, Chicago 37, Illinois.

COLUMBIA UNIVERSITY

Emphasis in the 1944 Summer Workshop for Science Teachers at Teachers College, Columbia University, will be on two areas: (1) the technological use of energy and materials, and (2) science and technology in agriculture. These will be examined with particular attention to scientific developments, to available resources, and to the effects of developments on local, national, and world economy. The work of the engineer and the scientist in the world of today will also be examined, and a general interpretative study will be made of the future of agriculture. The activities of the Workshop will be carried on (1) with the help of expert consultants, who will present reports of scientific studies to the Workshop members and discuss with them the effects of these studies on our society; (2) by consideration on the part of Workshop participants and consultants in education of the meaning for science teachers of the research studies and their social effects; and (3) by individual and group study by the participants of ways of adapting their science teaching to the needs of youth.

Professor Samuel Ralph Powers, Head of the Department of Teaching of Natural Sciences, will direct the Workshop. Further information concerning it may be obtained by writing to Professor Powers.

WELLESLEY COLLEGE

The Wellesley School of Community Affairs, which, it is hoped, will continue for three successive summers, will deal with typical problems facing citizens of towns and cities throughout the United States today. The topic of the School for the summer of 1944 will be "Cultural Differences within the American Community"; the Director of the 1944 session will be Dr. Margaret Mead, Associate Curator of the American Museum of Natural History.

The School will offer three successive units of study in separate but related two-week periods. The first unit will be designed for teachers, youth leaders, and others who encounter intercultural situations in dealing with young people. The second, for personnel officers, trades-union education secretaries and vocational guidance counselors, will deal with the problem of group relationships in industry. The third unit will be planned for community and social workers, local governmental agents, group leaders both lay and clerical, voluntary board members of civic associations, and members of interracial committees.

Additional information concerning the School of Community Affairs will be sent on request. For further details, address Miss Edith R. West, Wellesley College, Wellesley, Massachusetts.

ABSTRACTS

BURNHAM, GEORGE H. "Report on Physics Teaching Personnel—Spring, 1943." *American Journal of Physics* 11: 324–327, December, 1943.

Data obtained from questionnaires distributed to institutions of higher learning in February and March, 1943, indicate that there were not more than four thousand persons engaged in teaching courses in physics in colleges. The total teaching load was 14.6 clock hours per week per individual. A total shortage of 404 teachers was indicated. Many institutions have carried on in-service training courses for staff members not experienced in teaching physics.

—C.M.P.

SEASHORE, CARL E. "An Educational Decalog." *School and Society* 58: 353–358, November 6, 1943.

The author lists and briefly discusses the following ten leading principles in education for "freedom to learn": (1) Recognize individual differences; (2) make education student-centered; (3) build a basic, unified, individual program; (4) organize training for self-help in learning; (5) make motivation the chief medium of instruction; (6) eliminate lockstep in assignment and promotion; (7) integrate the school with community life and career; (8) make education continuous from cradle to grave; (9) be just in awarding praise and blame on the basis of capacity; (10) aim to develop in the individual a well-rounded personality.

—C.M.P.

CALDWELL, OTIS W. "Post-War Education—Where Are We Now?" *A.A.A.S. Bulletin* 2: 89–90, December, 1943.

Universal education is our goal, and we are constantly striving toward reaching it. Time was when the classroom was only for children and their teachers. Slowly but surely it was recognized that the best educated individuals never finish their education. College enrollments increased as teachers, lawyers, doctors, and business men and women attempted to further their education. The adult education movement is general recognition that education does not cease. Our educational system fails to live up to its promise of universal free education for all. It is still patterned after programs designed for the specialized groups.

—C.M.P.

KUNZE, ALBERT F. "The Amazon—Has It Been Fully Discovered?" *Scientific Monthly* 58: 16–23; January, 1944.

An interesting story is herein related of the history—discovery and explorations; geography, cartography, and geology; natural history—botany, zoology, and ornithology; engineering and navigation—of the Amazon (which drains a basin over twice as large as that of our Mississippi); and some of the products and countless possible developments in the future. On this river ocean-going vessels can voyage 2,000 miles "inland."

Not the least interesting feature of the article is that it is developed around and illustrated with photographs of the postage stamps of Peru, Ecuador, and Brazil which celebrate the four-hundredth anniversary of the discoveries of Gonzalo Pizarro and Francisco de Orellana in this river basin.

Its products, rubber and quinine—which have urgent importance due to the War—also include "woods of a wide variety, fibers, tin, manganese, and other natural resources in quantities and grades still unknown," as well as vegetable ivory, babassú nuts, and the many products of the carnauba palm. It is "still a vast region of undiscovered treasure," challenging science as another great frontier.

—M. E. Oakes.

The *Teachers College Record* for January, 1944 (Vol. 45, No. 4), is a special science number. It contains eight major articles on science education, in which the social role of science teaching is interpreted against the varied background of the authors. This issue of the *Record* is in a sense a progress report of the Department of Natural Sciences of Teachers College, Columbia University, and as such it builds on an earlier science issue of the *Record*, that for January, 1939. Brief comments on the several articles follow.

CRAIG, GERALD S. "The Social Role of Science." Pp. 219–224.

Science is profoundly changing the kinds of outlook that man has toward the physical and biological aspects of the universe that surrounds him. Professor Craig discusses the following major theses: (1) science a new element in society; (2) science consistent with democracy; (3) shaping the future through science; (4) science and improved living conditions; (5) science and social security; (6) the challenge to education.

LATON, ANITA D., AND MEDER, ELSA MARIE. "Toward Unified Learning." Pp. 225–233.

Teaching is effective when it is rooted in the needs and problems of people in the community and its schools. Major problems discussed include: (1) the community survey; (2) problems of communities; (3) problems of human living; (4) integrated courses. This article reports on work that is being done in a number of widely distributed public and private schools.

Powers, Samuel Ralph. "The Science Teacher and the Changing Functions of Secondary Education." Pp. 234–240.

The objectives of education are derived from the needs of people and communities in which they live. The interpretation of needs today is sharply in contrast with the interpretation made a generation ago. All of this means an emphasis on: education for life; improvement in health standards; improvement in the use of materials; increase in production; wise utilization of materials; transportation and communication; and a direct approach to the study of significant issues.

Two major needs are to be recognized in considering the future of science teaching. One is for general education of all to share ideals and work with intelligence and cooperation for the advancement of the common welfare. The second need is to help each youth to find a field of special interest and to study intensively in that field.

Burnett, R. Will. "The Science Teacher and His Objectives." Pp. 241–251.

There are three traditional major approaches to curriculum construction in science: (1) the field-covering approach; (2) the generalization approach; and (3) the needs or functional area approach. The author analyzes the need for developing critical and incisive thinking into twenty-three possible objectives that may contribute to the meeting of this need.

Evans, Hubert M. "The Teacher of Science and His Community." Pp. 252–259.

This article suggests methods by which the teacher of science may utilize more fully the resources of the community. Problems which may be utilized include: (1) community setting; (2) housing; (3) health; (4) nutrition; (5) group relationships; (6) energy and material resources; (7) capital resources. General outcomes of community study, derived from the experiences of teachers who have worked on community problems, are stated, and their use in evaluation is indicated.

Bingham, N. Eldred. "Teaching Science and the Community." Pp. 260–264.

This article discusses methods by which science teaching may be made more functional for the individual pupil. It attempts to clarify what is meant by "the scientific approach" in the classroom.

Brandwein, Paul F. "The Modern Role of Biology Teaching." Pp. 265–271.

Biology teaching has two major problems: (1) the problem of contributing to the well-being of the individual, and (2) the problem of contributing to the well-being of the community. A modern biology course must be based on a modern concept of biology—the organism is the product of its heredity and environment. This

makes clear the responsibility of biology teachers, for "every plant, every animal, every human being can be improved by improving either its heredity, or its environment, or both."

BENJAMIN, THEODORE D. "The Modern Role of Physical Science Teaching." Pp. 272–279.

The author analyzes the contributions that physical science teaching can make to better individual, group, and community living. In addition, there is the contribution now being made to winning the war, and the vital part science teaching can play in helping victory lead to lasting peace.

—C.M.P.

Among the materials on elementary science in the *Instructor* for 1943 (Volume 52) are the following articles, not previously noted in these columns:

HOWELL, MABEL B. "An Aviation Unit." (March.)

This unit planned for the primary grades includes: approaches, procedure and correlations.

MORROW, HELEN C. "The Man Who Struck Oil." (March.)

This is a historical play for middle and upper grades.

YOUNG, DOROTHY LOCK. "A Schoolroom Weather Bureau." (March.)

This middle grade unit includes: objectives, equipment, organization, results, and activities.

GALFORD, MARY. "Steel and Our Defense." (March.)

This science unit intended for the middle and upper grades includes: objective, motivation, procedure, and bibliography.

CONDIT, LOUISE. "War Alters Children's Science Interests." (April.)

Children's interest in various activities of war involving many science principles is only normal and natural and should be fully utilized in the classroom.

GRIMM, DOROTHY H. "Facts for Future Flyers." (March, April, May, June, and September.)

These are unusually fine articles, well illustrated. Material includes: "How an Airplane Flies," "Traffic Rules of the Air," "Weather for Flying," "Tips for Model Builders," "Identification," "Yesterday and Today," "Integration," and "Question Box."

TOBIAS, ADDA. "Walks for Very Young Scientists." (September.)

This unit is intended for the primary grades. Objectives are listed and several suggested walks throughout the year are suggested. Teacher preparation, teacher-pupil preparation, outline of the trip, and follow up are presented for each walk.

ROSE, JENNIE. "A Unit on Communication." (September.)

This is a science unit suitable for the middle and upper grades. Meanings to be developed, teacher objectives, pupil objectives, problems, subject-matter outline, information obtained, and a bibliography are included.

WAGNER, CELIA B. "The Pageant of Cotton." (September.)

This is a middle and upper grade unit, emphasizing the importance of cotton and its new uses in peace and war.

TRACHT, NETTIE WISE. "Fun with Seeds and Leaves." (September.)

This is a science play intended for the primary grades.

TAYLOR, WILLA LEE. "How Vital Needs Are Met." (November.)

This is an excellent upper grade unit. An overview and study outline are presented. Major points in the study outline are: (1) Early history of coal; (2) where coal is found; (3) kinds of coal; (4) some by-products of coal; (5) from coal mine to cellar. A list of activities, understandings, discussion questions, and bibliography are included.

—C.M.P.

Sax, Karl. "Population Problems of a New World Order." *Scientific Monthly* 58: 66–71, January, 1944; and

Tang, Pei-sung. "Helios and Prometheus: a Philosophy of Agriculture." *Scientific Monthly* 58: 169–175, March, 1944.

These two closely related papers are fundamentally concerned with the problem of food supply for the human race. The reader will find data to give pause for thought. Problems for functional mathematics may be found in every paragraph. Doubtless the conclusions offered are "realistic" to the authors—one an Oriental, the other an Occidental; to those so inclined, these same conclusions might be designated "pessimistic."

At present, world population is over two billions; cultivated land per capita is only two acres. Population pressure has of old been relieved by famine, pestilence, natural catastrophies, or by aggression and slaughter by an invader. In crowded regions there is intensive cultivation: higher yield per acre but less production per man, i.e., more mouths to feed, resulting in low standards of living and inadequate nutritional standards.. There are other paths of escape from population pressure: industrialization and modern methods of transportation, migration to less crowded regions of which there are few, and limitation of birth rate.

Tang seems hopeful of some chemical substitute for the green plant; Sax seems to consider such possibility as chimerical. The latter, however, concludes, "Man has been able to control his environment to a remarkable degree, and there is no reason why he should not be able to control his social evolution. But it cannot be done by abandoning rational thought and reverting to mysticism. We need more of the scientific method, particularly in the field of social relations and human conduct."

—M. E. Oakes.

Tseng, C. K. "Agar: A Valuable Seaweed Product." *Scientific Monthly* 58: 24–32, January, 1944.

A much-needed product previously obtained commercially from Japan, agar is being increasingly obtained from different marine plants on our own Pacific shores and elsewhere.

The present process of its manufacture dates back to the middle of the seventeenth century. In the Orient agar is used for bulk and flavor in the diet; at present agar has many uses in medicine and science: as microbiological culture medium, as laxative, for dental impression mold, to stabilize emulsions, as dressing on wounds, etc.; in industry it is used in fabric-sizing, to render rice paper more durable, for waterproofing, to prevent corrosion, in insect sprays, in lubricants, in photographic film, and numerous other ways.

The author speaks from wide experience.

—M. E. Oakes.

BOOK REVIEWS

GENERAL BOOKS AND REFERENCE WORKS

McKAY, HERBERT. *Odd Numbers or Arithmetic Revisited.* New York: The Macmillan Company, 1943. 215 p. $2.00.

Odd Numbers is written in the typical English style, discernible in the first paragraph and evident throughout. The book would prove interesting and entertaining to mathematics teachers and those interested in mathematics. Most high school students would find it rather dull as parts of the book require quite a bit of mathematical background. Many English terms would mean little to the average American—half-crown, sixpence, stones, florin, and so on. Even the English billion and trillion are not the same as the American billion and trillion.

Odd Numbers is a delightful book in practically all respects and all mathematics teachers can gain some valuable suggestions that will rekindle their own thinking, and could revivify some of their own classroom teaching, should they call to the attention of their students some of the "unusual" in arithmetic.

—C.M.P.

MAYER, A. W. *Chemical Technical Dictionary.* Brooklyn: Chemical Publishing Company, Inc., 1943. 872 p. $8.00.

This seemingly complete chemical technical dictionary will be very useful for those studying Russian, French and German chemical literature. Translators and college students of the above languages will find it most useful, also. The German word is first given, then the English, followed by the French, and the Russian.

—C.M.P.

SMITH, PAUL I. *Synthetic Adhesives.* Brooklyn: Chemical Publishing Company, Inc., 1943. 125 p. $3.00.

This is a practical book, easily understood, emphasizing the great demand for synthetic adhesives in many war-time industries, in plywood, in laminating of cloth, and so on. These synthetic adhesives have greatly increased speed in production, strength, reliability, and water and fungi resistance.

—C.M.P.

JAMES, GLENN, AND JAMES, ROBERT C. *Mathematics Dictionary.* Van Nuys, California: The Digest Press, 1943. 319 p. $3.00.

According to the authors this is the only mathematics dictionary that has been printed in modern times. As such, it should be enthusiastically received by workers in the fields of mathematics and the physical sciences. The meaning of the basic mathematical words and phrases, from arithmetic through calculus, and the technical terms commonly used in the applications of these subjects aptly describes the content. Many working examples have been included. Both popular and technical definitions are given when feasible. Definitions are the majority usage, checked against foremost modern authorities, and criticized by specialists in various fields.

—C.M.P.

BEBIE, JULES. *Manual of Explosives, Military Pyrotechnics and Chemical Warfare Agents.* New York: The Macmillan Company, 1943. 171 p. $2.00.

This authoritative treatise presents the composition, properties and uses of known explosives, military pyrotechnics and chemical warfare agents. The various materials are listed alphabetically beginning with abbcite and ending with zirconium. There is an excellent chronology as well as bibliography.

—C.M.P.

GABRIELSON, IRA N. *Wildlife Refuges.* New York: The Macmillan Company, 1943. 257 p. $4.00.

Dr. Gabrielson is the man chiefly responsible for the development of the great wildlife refuge system of the United States, the greatest of its kind in the world. We now have in the United States and Alaska about 17,000,000 acres of wildlife refuges and sanctuaries, including nearly 4,000,000 acres for waterfowl. Dr. Gabrielson is Director of the Fish and Wildlife Service of the United States Department of Interior.

Wildlife Refuges describes the various refuge systems, their present conditions, and future possibilities. Altogether this book is a story of accomplishments, of great things that have already been done in this most important aspect of conservation.

—C.M.P.

CHRISTENSEN, CLYDE M. *Common Edible Mushrooms.* Minneapolis: The University of Minnesota Press, 1943. 124 p. $2.50.

The choicest and most delicious mushrooms are found almost everywhere out of doors and cannot be cultivated. For more than twenty centuries mushrooms have ranked among the most savory of foods. The authors maintain that it is extremely easy to recognize a few of the common edible ones but to avoid all others. More than fifty edible types are described. There is a special chapter on "The Foolproof Four"—morels or sponge mushrooms, sulfur shelf mushrooms, puffballs (common on decaying wood and in meadows) and shaggymanes. It is really surprising how many edible mushrooms exist. There is an excellent final chapter on mushroom cookery.

—C.M.P.

COLLEGE TEXTBOOKS AND MANUALS

HARROW, BENJAMIN. *Textbook of Biochemistry.* Philadelphia: W. B. Saunders Company, 1943. 537 p. $4.00.

The story of biochemistry as given in this text more than covers the usual requirements for medical, dental, agricultural, and general college students. This third edition has been prepared to meet the rapid advances made in biochemistry, and contains a new chapter on sulfa drugs, arsphenamine, and similar topics. Numerous subjects have been brought up to date as: expansion on vitamins, fluorine and tooth decay, the enriching of foods, blood plasma and the war, hormones and carbohydrate metabolism and the newer views on acetone bodies. There are 118 illustrations.

—W.G.W.

RANSON, STEPHEN WALTER. *The Anatomy of the Nervous System.* Philadelphia: W. B. Saunders Company, 1943. 520 p. $6.50.

In this treatment of the nervous system emphasis is laid on the development and functional significance of structure, keeping the needs of medical students in mind. In this latest edition the author has made extensive revision of the sections on the cerebellum, thalamus, hypothalamus and cerebral cortex. The chapter on the sympathetic nervous system has been completely rewritten. Treatment of the science of neurology has been increased. There are 408 excellent illustrations, some of them in color.

—W.G.W.

MILLAR, C. E., AND TURK, L. M. *Fundamentals of Soil Science.* New York: John Wiley and Sons, Inc., 1943. 462 p. $3.75.

Fundamentals of Soil Science is intended for use as a college textbook and as a reference work for general readers and farmers desiring information on soils and their culture. General principles of soil science are emphasized and explained.

—C.M.P.

BAWDEN, ARTHUR T. *Man's Physical Universe.* New York: The Macmillan Company, 1943. 832 p. $4.00.

This text covers the fields of physical science commonly dealt with in survey college courses. The author has been highly successful in his treatment of material, to make it meet his desire "that the student be led to develop open, critical, and cultural attitude of mind that will lead him to attempt to use the scientific method in solving the important problems of life." The book is interestingly written, well illustrated, and brings science interpretations into real life situations. Study questions at unit ends help students in their reviews.

—W.G.W.

STILES, KARL A. *Laboratory Explorations in General Zoology.* New York: The Macmillan Company, 1943. 265 p. $2.50.

The word "explorations" in the title suggests the real purpose of this book; that is, to stimulate the college student of general zoology to discover for himself the interesting facts of zoology. Relatively complete instructions for procedure are given, although not so many that the student's initiative is not challenged. The assignments may be used with any good text of general zoology, or independent of a textbook.

At the end of each unit of work are suggested drawings for the student to make, as well as several demonstrations which may be made. The great number of questions at the end of each unit not only stimulates library work, but it is also excellent for review and self-testing. A section of the book is given to outline drawings which would conserve the student's time.

—Roy V. Maneval.

PUTNAM, WILLIAM C. *Map Interpretation with Military Applications.* New York: McGraw-Hill Book Company, 1943. 67 p. $1.25.

The material treated was prepared primarily for Army and Navy R.O.T.C. students and is of a practical nature. The large page (8½ x 11 inches) makes large-scale maps and photographs possible. The four main divisions of the book are: Contour Maps, Aerial Photography, Geological Interpretations, and Erosive Processes. The book provides a background for understanding the significance of landscape as represented on maps. This is very important for those planning strategy in warfare.

—W.G.W.

KING, BARRY GRIFFITH, AND ROSER, HELEN MARIA. *Anatomy and Physiology Laboratory Manual and Study Guide.* Philadelphia: W. B. Saunders Company, 1943. 253 p. $2.75.

This is a second edition of a well-known anatomy and physiology manual intended to give a nurse a good working knowledge of anatomy and physiology in line with present-day trends in nursing schools and progressive teaching everywhere. The present edition offers a relatively large number of exercises allowing the instructor considerable freedom in selecting material to be taught and adapting the material to the particular needs and facilities of a particular school. The manual can be used with any of the standard texts on anatomy and physiology.

There are five units making up the contents of the manual; namely, The Body as an Integrated Whole, The Erect and Moving Body, Metabolism of the Body, Reproductive System, and the Nervous System.

—Greta Oppe.

Best, Charles H., and Taylor, Norman B. *The Physiological Basis of Medical Practice*, 3rd edition. Baltimore: The Williams and Wilkins Company, 1943. 1942 p. $10.00.

This comprehensive manual gives both the medical student and the young doctor those fundamental principles of physiology which aid in the interpretation of symptoms and direction of treatment. It serves as a connecting link between the laboratory and the clinic. So many important advances in the field of physiology were made in the years immediately succeeding the second edition that this revised third edition became imperative. The book is divided into nine sections: (1) The blood and lymph; (2) The circulation of the blood; (3) Respiration; (4) The excretion of urine; (5) Digestion; (6) Metabolism and nutrition; (7) The ductless glands or endocrines; (8) The nervous system; (9) The special senses. There are 497 illustrations, some of them in color. Nearly a hundred pages at the end of the book provide an excellent bibliography including references to specific chapters in the text. —W.G.W.

Kolthoff, I. M., and Sandell, E. B. *Textbook of Quantitative Inorganic Analysis*, Revised Edition. New York: The Macmillan Company, 1943. 794 p. $4.50.

This is a text that may be used in a beginning course in analytical chemistry, but at the same time it introduces the student to the highly-specialized methods of analysis suitable for advanced work. The authors have provided a balanced outline of theoretical and practical aspects of inorganic quantitative analysis but have stressed the procedures of analysis. The large divisions of the book are: Gravimetric Analysis, Volumetric Analysis, Physio-Chemical Methods, and Analyses of Complex Material. There are 131 diagrams.

—W.G.W.

Macy, Rudolph. *Organic Chemistry Simplified*. Brooklyn: Chemical Publishing Company, Inc., 1943. 431 p. $3.75.

This interestingly written and authoritative book will be a great help to one who is just beginning a study of organic chemistry and to one whose training in organic chemistry was a decade ago. For the latter it will explain the new knowledge in chemistry as it is applied to organic compounds and their reactions. Part I, consisting of eight short chapters, covers the mechanics of atoms and molecules, explains valence, and describes the unique position of carbon among the elements. The octet system is applied to the atom, and polar and non-polar molecules are explained. Part II takes up the architecture of carbon compounds; Part III classifies carbon compounds; Part IV treats various special topics of organic chemistry, giving information on chemotherapy, hormones, vitamins, isotopes, polymers, and thermoplastics. Many graphic formulas and diagrams are used.

—W.G.W.

Hartsuch, Bruce E. *Elementary Qualitative Analysis*. New York: John Wiley and Sons, Inc., 1943. 274 p. $2.75.

Unlike many qualitative analysis manuals, this one does not stop with giving directions and expect the student to know the reasons for each process or to look them up in some other book. In this volume the student has the basic information explained in very simple language. As he progresses, more technical terms are used. The combination of text and laboratory directions helps the student refrain from thinking of classroom work as unrelated to the laboratory work. The laboratory sheets have spaces for student answers to pertinent questions on each group of analysis. Summaries and other notes as aids are helpful to the student.

—W.G.W.

HIGH SCHOOL TEXTBOOKS, MANUALS, AND TESTS

Davis, Ira C., and Sharpe, Richard W. *Science*. New York: Henry Holt and Company, 1943. 495 p. $1.80.

This is a revision of a general science text that has been arranged with especial care for continuity, teachability, and student interest. Each chapter begins with the story of progress and discovery. A large number of pictures and diagrams are used. Several review and thought questions are provided in each chapter.

The authors have endeavored to present the subject in such a way that it will appeal to the interest of high school students, and at the same time build up in them a lasting scientific attitude of mind. The content relates to the common activities, interests and experiences of the students.

An excellent forty-five page teacher's manual is available for use with this text.

—Roy V. Maneval.

Carnegie-Illinois Steel Corporation. *Fundamentals of Electricity*. New York: American Book Company, 1943. 194 p.

This book has been prepared to answer the nation's demand for defense training classes at a beginning level. It is assumed that ninety periods are to be devoted to the subject of the fundamentals of electricity as required for more than thirty-five Army occupations. It is suggested that seventy-six periods be devoted to the discussion of the text, nine to the laboratory exercises included in the text, and five to the problems. This is another of those excellent books written for wartime economy, but the experience obtained from the study of such a book ought to instill in the minds of those who study it a feeling that such information is necessary in molding the lives of people for useful jobs in any industrial effort.

—Greta Oppe.

Clark, John A., Gorton, Frederick Russell, Sears, Francis W., and Crotty, Major Francis C. *Fundamentals of Machines.* New York: Houghton Mifflin Company, 1943. 300 p. $1.24.

This book follows topic by topic the outline of the official pre-induction training course in machines prepared jointly by the War Department and the U. S. Office of Education. An examination of the book will show that it is written clearly, and each principle of machines is developed step by step.

Demonstrations and experiments are an integral part of the explanations, and thus help to make concrete the principles involved. Use is made of many drawings and photographs to furnish evidence of facts and phenomena and to add reality to the printed matter.

Each unit of the several problems is followed by a self-test and exercises based on the principles of the unit. In addition to its use in pre-induction training courses, *Fundamentals of Machines* would be an excellent reference book for high school physics courses.

—Roy V. Maneval.

Dull, Charles E. *Modern Physics.* New York: Henry Holt and Company, Inc., 1943. 613 p. $2.00.

This is a real revision in more ways than one. There is, naturally, new material covering recent advances in science, but the striking thing is the new format. The larger double-column pages and larger diagrams improve the appearance greatly. The new book is divided into *Units.* A Unit may include one or several chapters of the old book, and much of the material has been rewritten. Each Unit has a preview, a vocabulary of new terms, a summary, questions, and problems. Of the 842 illustrations the majority are line cuts, but there are many half tones and a few color plates. The book maintains the same high standard as its predecessor.

—W.G.W.

Wallendorf, Charles R., Stewart, Frank, Luedeke George, and Chiarello, Domenic M. *Machines.* New York: American Book Company, 1943. 300 p. $1.24.

Here is another pre-induction training book on machines. It contains all the topics listed in the War Department's Outline PIT 102, but classroom experience with high school pupils has dictated the sequence and method of presenting these topics to make this pre-induction course both interesting and profitable. The applications are drawn from the military service, the factory, and the field. The last chapter is a detailed study of the automobile with an excellent illustrated and summarized discussion of simple machines found in the automobile. This is indeed a practical volume for not only the shop but the school library.

—Greta Oppe.

Lebowitz, Samuel H. *Machine Science.* New York: John Wiley and Sons, Inc., 1943. 440 p. $2.50.

This book was written to present in one volume, the subject matter required in the course on *Fundamentals of Machines* as outlined by the U. S. Office of Education and the U. S. War Department for pre-induction training. There are fourteen chapters dealing with simple machines, the theory of machines and their fundamentals, the work of machines and their fuels, and units of measurement. The physics and chemistry of machines are so carefully developed from a practical viewpoint that the information set forth in this fine textbook ought to make a permanent impression on the mind of the student. While such a book is written primarily for pre-induction training, its true worth lies in the type of education it does provide for a complex post-war period when scientific knowledge and technical skill will be so much in demand.

—Greta Oppe.

Johnson, William H., and Newkirk, Louis V. *Fundamentals of Electricity.* New York: The Macmillan Company, 1943. 212 p. $2.00.

This pre-induction text is based on training outlines of the War Department and the U. S. Office of Education. A course in the fundamentals of electricity lays the foundation for Army specialization. It will equip the student with the basic skill necessary for participation in Army jobs such as automobile mechanic, telephone and telegraph lineman, airplane mechanic, fire-control instrument operator, telephone operator, electrician, and radio operator.

Fundamentals of Electricity is designed to provide at least seventy-six periods of demonstration-discussion, nine periods of laboratory exercises, and five periods of review and testing. The authors, two Chicago school men, have used materials and equipment which are economical and in keeping with the war program. Each chapter has a summary, list of questions, problems, bibliography, and list of visual aids. The book is well illustrated by use of photographs and drawings.

Teachers of electricity, physics, and pre-induction courses should examine this new and authoritative book.

—Roy V. Maneval.

Lapp, C. J., Knight, F. B., and Rietz, H. L. *Mathematics for the Emergency.* Chicago: Scott, Foresman and Company, 1943. 158 p. $0.80.

The materials of this text would serve admirably either as a "refresher" course or as a pre-induction survey of mathematics for boys and girls going into military service and defense work. Fundamental materials have been selected from arithmetic, algebra, geometry, and trigonometry. The latter two are emphasized only slightly. Major emphasis is on algebra.

—C.M.P.

Cornetet, Wendell H., and Fox, Daniel W. *Principles of Electricity*. Bloomington, Illinois: McKnight and McKnight, 1943. 255 p. $1.60.

This book was prepared to provide enriched war time courses in practical science and mathematics as related to electricity. The material is so well presented from the standpoint of informational units, operative units, and objective and mastery tests that it should make a definite contribution to the man-power needed for the specialized occupations required by modern armed forces as well as present day industrial plants.

—Greta Oppe.

Trafton, Gilbert H., and Smith, Victor C. *General Science Workbook*. Chicago: J. B. Lippincott Company, 1943. 309 p. $1.00.

This is a revised edition of a well-known general science workbook by two outstanding science teachers and textbook writers. The makeup of the book and its organization have been given great care. There are seventeen useful units typical of the popular general science textbooks and courses of study in general science. The suggestions to the student as to the use of the workbook are especially fine: "Think carefully. You cannot guess or 'bluff'." "Be honest. You cannot loaf in practice and be a star in the game of life." The workbook is illustrated. Unit Tests are furnished free for the teacher.

—Greta Oppe.

Shea, William C. *Pre-Service Course in Electricity*. New York: John Wiley and Sons, Inc., 1943. 276 p. $1.52.

This text was prepared at the request of the War Department and the U. S. Office of Education and covers the official outline for pre-induction training. The material was drawn from technical and field manuals of the War Department. The book offers boys about to enter military service a first course in the fundamentals of electricity. It is really a prerequisite course to work in radio, aviation and motor mechanics. There is work planned for 90 teaching periods. It is well suited to the abilities of high school students. The book is well illustrated with halftones and line cuts. A summary and review questions follow each chapter. —W.G.W.

Gruenberg, Benjamin C., and Obourn, Ellsworth, S. *Instructional Tests in Machines. Instructional Tests in Electricity*. Yonkers-on-Hudson: World Book Company, 1943. 36 p.; 32 p. $0.16 each.

These tests cover the pre-induction courses 101 and 102 in fundamentals recommended by the War Department. The tests are of various types: missing-word, best-answer, association, completion, and true-false. They offer excellent review since they cover the ground very thoroughly. There are answer sheets and keys for scoring, making correction an easy task.

—W.G.W.

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    Addinall, C. R. "Recent Chemotherapeutic Advances." *Science Education, 27*: 10–15, February, 1944.
    National Society for the Study of Education. *Thirty-First Yearbook, A Program for Teaching Science,* pp. 107–108. Public School Publishing Co., Bloomington, Ill., 1932.

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